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SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
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The Secretary of the Interior has deterimined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 1991.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several services of the Water Resources Scientific Information Center. The cumulative SWRA file from 1968 and monthly updates are available also in magnetic tape through lease from NTIS.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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Includes the following Groups: Properties; Aqueous Solutions and Suspensions.

02 WATER CYCLE

Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control.

06 WATER RESOURCES PLANNING

Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

07 RESOURCES DATA

Includes the following Groups: Network Design; Data Acquisition; Evaluation, Processing and Publication.

08 ENGINEERING WORKS

Includes the following Groups: Structures; Hydraulics; Hydraulic Machinery; Soil Mechanics; Rock Mechanics and Geology; Concrete; Materials; Rapid Excavation; Fisheries Engineering.

09 MANPOWER, GRANTS, AND FACILITIES

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SUBJECT INDEX

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2A. General

HYDROLOGIC DATA BASE MODEL.
South Florida Water Management District, West Palm Beach.
For primary bibliographic entry see Field 7C.
W91-03047

APPROPRIATE METHODOLOGIES FOR DEVELOPMENT AND MANAGEMENT OF GROUNDWATER RESOURCES IN DEVELOPING COUNTRIES. VOLUME III.
For primary bibliographic entry see Field 2F.
W91-03178

MAIN INDUCED CHANGES IN RAINFALL-RUNOFF RELATIONSHIP FOR A MOUNTAINOUS WATERSHED.
Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
A. Ben-Zvi, and M. Langerman.
Pirineos: Revista de Ecologia de Montana PRNOAJ, Vol. 134, p 9-21, 1989. 3 fig, 6 tab, 7 ref.

Descriptors: *Cloud seeding, *Hydrologic models, *Israel, *Mountain streams, *Rainfall-runoff relationships, *Small watersheds, Flow discharge, Regression analysis, Runoff volume, Watershed management.

Historical comparison of records for a small mountainous watershed in Israel indicates a substantial reduction of the flow volume with regard to the rainfall depth. A rainfall-runoff model of the linear regression type was used to study the data. Cloud seeding has been shown to cause an increase in the runoff volume with regard to the rainfall. The only other known factor which can be so effective is the extensive watershed management operation carried out in this area in the 1950s. With regard to the rainfall depth, the mean annual volume of the flow has decreased by 45% of its historic value. (Author's abstract)
W91-03432

GLOBAL RIVER RUNOFF CALCULATED FROM A GLOBAL ATMOSPHERIC GENERAL CIRCULATION MODEL.
National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies.
G. L. Russell, and J. R. Miller.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 241-254, September 1990. 5 fig, 3 tab, 20 ref.

Descriptors: *Atmospheric circulation, *Climatology, *Hydrologic models, *Model studies, *Rivers, *Runoff, *Runoff forecasting, Evapotranspiration, Groundwater storage, Parameterization, Precipitation, Rainfall-runoff relationships.

An atmospheric general circulation model was used to calculate runoff for the major rivers of the world. The model has a horizontal resolution of 4 x 5 degrees, but the runoff from each grid box within a particular river's drainage basin was summed on a resolution of 2 x 2.5 degrees to obtain the runoff at the river mouth. The mean annual runoff was calculated and compared with observations for 33 of the world's largest rivers. For about half of the rivers with annual runoff in excess of 200 cu km, the model runoff is within about 20% of the observed value. The model overpredicts the runoff for rivers with less than 200 cu km/yr. Some of the inaccuracy in the runoff predictions occurs because of poor model precipitation fields, but the model's parameterizations of groundwater storage and evapotranspiration are also suspect. New parameterizations, including the effects of both soil type and vegetation, should be investigated. In addition to being a good diagnostic for atmospheric modelers, the runoff that may occur during future climate changes can also be studied with these models. (MacKeen-PTT)
W91-03551

ASSESSING HYDROLOGIC MODEL NONLINEARITY USING RESPONSE SURFACE PLOTS.
Newcastle Univ. (Australia). Dept. of Civil Engineering.
G. Kuczera.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 143-161, October 1990. 16 fig, 3 tab, 18 ref.

Descriptors: *Hydrologic models, *Model studies, *Multivariate analysis, *Parametric hydrology, *Uncertainty, Case studies, Numerical analysis, Probability distribution.

When a conceptual hydrologic model is calibrated to observed data, a posterior distribution summarizing uncertainty about model parameters can be derived. For models with more than two parameters, this distribution can be very awkward to work with. However, when a model is approximately linear over the region of parameter space with appreciable posterior density, the posterior distribution can be approximated by a multivariate normal distribution which provides a powerful tool for studying parameter uncertainty, testing hypotheses, and determining the reliability of model predictions. Model nonlinearity can be assessed using numerical measures. Complementing these measures are response surface plots. When interpreting response surface plots for models with more than two parameters, it is argued that linearized conditional probability regions should be displayed on response surface plots to highlight the region of likely parameter values. Where significant parameter interaction exists, it is possible that only a small fraction of the response surface will display probable model parameter values. In such cases, generating the response surface in principal component planes is computationally more efficient. Two case studies using four-parameter conceptual hydrologic models illustrate these points. (Author's abstract)
W91-03745

INITIAL CONTRIBUTING AREA OF A SMALL WATERSHED.
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
For primary bibliographic entry see Field 2E.
W91-03760

CLIMATE FACTOR FOR SMALL-BASIN FLOOD FREQUENCY.
Geological Survey, Denver, CO. Water Resources Div.
R. W. Lichty, and M. R. Karlinger.
Water Resources Bulletin WARBAQ, Vol. 26, No. 4, p 577-586, August 1990. 4 fig, 10 tab, 17 ref.

Descriptors: *Climatology, *Flood basins, *Flood forecasting, *Flood frequency, *Hydrologic models, *Rainfall-runoff relationships, Climatic data, Data interpretation, Flood data, Kriging, Mathematical analysis, Mathematical models, Regression analysis, Watersheds.

A climate factor, CT, (T = 2-year, 25-year and 100-year recurrence intervals) that delineates regional trends in small-basin flood frequency was derived using data from 71 long-term rainfall record sites. Values of CT at these sites were developed by a regression analysis that related rainfall-runoff model estimates of T-year floods to a sample set of 50 model calibrations. CT was regionalized via kriging to develop maps depicting its geographic variation for a large part of the United States east of the 105th meridian. Kriged estimates of CT and basin-runoff characteristics were used to compute regionalized T-year floods for 200 small drainage basins. Observed T-year flood estimates also were developed for these sites. Regionalized floods are shown to account for a large percentage of the variability in observed flood estimates with coefficients of determination ranging from 0.89 for 2-year floods to 0.82 for 100-year floods. The relative importance of the factors comprising regionalized flood estimates is evaluated in terms of scale (size of drainage area), basin-runoff characteristics (rainfall-runoff model parameters), and climate (CT). (Author's abstract)
W91-03853

RUNOFF VOLUME ESTIMATION USING GIS TECHNIQUES.
National Park Service, Denver, CO. Denver Service Center.
M. M. Stuebe, and D. M. Johnston.
Water Resources Bulletin WARBAQ, Vol. 26, No. 4, p 611-620, August 1990. 4 fig, 2 tab, 21 ref.

Descriptors: *Flood routing, *Geographic information systems, *Hydrologic models, *Rainfall-runoff relationships, Data interpretation, Mathematical analysis, Mathematical models, Simulation analysis, Surface runoff, Watersheds.

Rainfall-runoff of six watersheds was modeled via the Soil Conservation Service runoff curve number model in two ways: conventionally (manually) and via a geographic information system (GIS). Input data (elevation, soils and landcover) were digital for the latter method. In contrast to previous studies, the GIS was used for all phases of the modeling process, including watershed delineation and routing of runoff. A comparison between the two methods was consistent with results reported by others and indicates that the use of GIS is an acceptable alternative to the conventional method for watersheds lacking relatively flat terrain. Given this limitation, the GIS method may prove advantageous over manual methods when study areas are large or numerous, runoff is modeled repetitively, alternative landcover scenarios are explored, or a digital database already exists for the study area. (Author's abstract)
W91-03856

LINEAR PROGRAMS FOR NONLINEAR HYDROLOGIC ESTIMATION.
California Univ., Santa Barbara. Dept. of Geography.
For primary bibliographic entry see Field 2E.
W91-03859

VEGETATION AND CLIMATE OF THE LATE CAINOZOIC IN THE MURRAY BASIN AND THEIR BEARING ON THE SALINITY PROBLEM.
New South Wales Univ., Kensington (Australia). School of Biological Sciences.
H. A. Martin.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 291-299, 1990. 7 fig, 1 tab, 30 ref, append. Australian Research Grants Scheme.

Descriptors: *Australia, *Geochemistry, *Geologic history, *Murray-Darling River Basin, *Paleohydrology, *Saline groundwater, *Saline water intrusion, *Salinity, Forest hydrology, Forests, Geohydrology, Marine environment, Paleoclimatology, River systems, Salt marshes, Vegetation establishment.

The Murray Basin, in southeastern Australia, was forested throughout the Tertiary, becoming open woodlands and grasslands in Plio-Pleistocene time. Precipitation was very high through the early Tertiary, with step-like decreases beginning in the late Oligocene-early Miocene. In the mid-late Miocene, widespread rainforests disappeared and were replaced with eucalypt wet sclerophyll forests which were burnt on a regular basis. For a brief interval in the late Miocene-early Pliocene, there is a resurgence of Nothofagus which forms a well defined stratigraphic horizon. The Nothofagus phase is well marked in the major river systems of the western slopes of the Eastern Highlands, but it has also been found in the western Murray Basin. The climate was wetter at this time, which is thought to correlate with the late Miocene-early Pliocene maximum marine transgression. An assemblage with a high chenopod type and Asteraceae pollen content is deceptively like modern assemblages of arid regions, but close examination reveals a salt-marsh environment associated with the early mid-Miocene marine transgression. Throughout the Tertiary and into the early Pleistocene, the only indications of salinity are associated with marine/marginal marine environments. There is no evidence of dryland salinity, as seen today. (Author's abstract)

Field 2—WATER CYCLE

Group 2A—General

W91-03903

2B. Precipitation

SOIL CONSERVATION SERVICE CLIMATIC DATA ACCESS FACILITY.
Soil Conservation Service, Washington, DC. Resources Inventory Div.
For primary bibliographic entry see Field 7C.
W91-02998

ACID DEPOSITION IN MARYLAND: SUMMARY OF RESULTS THROUGH 1988.
Maryland Dept. of Natural Resources, Annapolis. Chesapeake Bay Research and Monitoring Div.
For primary bibliographic entry see Field 5B.
W91-03025

RUNOFF EFFECTS ON THE EFFICIENCY OF RAINDROP KINETIC ENERGY IN SHEET EROSION.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Soils.
For primary bibliographic entry see Field 2J.
W91-03148

UNIVERSAL INDEX FOR CALCULATING RAINFALL EROSIVITY.
Institute of Soil Science and Yield Prediction, Sofia (Bulgaria).
For primary bibliographic entry see Field 2J.
W91-03150

EXPERIMENTAL MODEL OF EVALUATING SOIL EROSION ON A SINGLE-RAINSTORM BASIS.
Istituto Sperimentale per lo Studio e la Difesa del Suolo, Florence (Italy).
For primary bibliographic entry see Field 2J.
W91-03163

STRUCTURE OF TROPICAL CYCLONES AND SURROUNDING REGIONS AS DETERMINED FROM OLS AND SSM/I IMAGERY ANALYSIS.
Air Force Geophysics Lab., Hanscom AFB, MA.
M. Glass, and G. W. Felde.
Available from the National Technical Information Service, Springfield, Virginia 22161, as AD-A210 320. Price codes: A02 in paper copy, A01 in microfiche. Report no. GL-TR-89-0167, 7 July 1989. 4 p, 7 fig, 8 ref.

Descriptors: *Infrared imagery, *Meteorological data collection, *Meteorology, *Remote sensing, *Satellite technology, *Storms, *Tropical cyclones, Algorithms, Clouds, Convective precipitation, Microwaves.

A group of tropical cyclones of varying peak intensities occurring in the western North Pacific during 1988 were selected for study. Infrared and visible imagery data from the Operational Linescan System (OLS) sensor and passive microwave imagery data from the 7-channel Special Sensor Microwave/Imager (SSM/I) sensor were used. Both instruments are on board the same polar-orbiting Defense Meteorological Satellite System satellite. Imagery analysis of each storm and surrounding environment was performed during different stages of its life. It was concluded that coincident SSM/I (microwave) and OLS (visible and infrared) imagery data show promise as a new tool for delineating the cloud band structure, locating the intense convective cells within the cloud bands, and locating the storm center of tropical cyclones. Wind speed and rain rate fields derived from SSM/I algorithms agreed qualitatively with known features of tropical cyclones. These derived parameters will become more useful as algorithms are refined. (Fish-PTT)
W91-03226

USER'S GUIDE FOR THE UPDATED SMITH-FEDDES MODEL.
Arvin/Calspan Advanced Technology Center, Buffalo, NY.
C. W. Rogers.
Available from the National Technical Information Service, Springfield, Virginia 22161, as AD-A210 254. Price codes: A04 in paper copy, A01 in microfiche. Report no. 7330-2, June 1985. 52 p, 5 fig, 2 tab, 6 ref, 4 append. Contract no. N00228-84-C-3157.

Descriptors: *Clouds, *Computer models, *Handbooks, *Meteorological data, *Model studies, Computer programs, Precipitation.

A User's Manual for Smith-Feddes (S-F) model for cloud moisture content has been developed to provide information necessary to use the system effectively. This S-F program uses height of cloud base and top, cloud type, cloud cover percentage, presence of precipitation and vertical profiles of temperature and pressure to provide vertical profiles of cloud condensed moisture content (CMC) and the distribution of cloud particle number concentration by particle size. When precipitation is present, the same information is provided for the precipitation, both in-cloud and below cloud base to the ground. The computer used is the CDC machine, code-named HAL, at the Naval Surface Weapons Center's Fleet Numerical Oceanography Center (FNOC). The S-F input is card image, free format for latitude and longitude, and 9 track, 1600 BPI magnetic tape for the RTNEPH (Real Time NEPHanalysis) cloud data and Terrain tapes. Output is printed. Input to PNTDAT temperature and pressure data is card image in directive format. Output from PNTDAT is card images on a temporary disk file called TAPE7, which is then read by the S-F program. Standard FNOC procedures for running a computer program on machine HAL are to be used. (Fish-PTT)
W91-03228

EFFECTS OF MISSING DATA ON THE CALCULATION OF PRECIPITATION-WEIGHTED-MEAN CONCENTRATIONS IN WET DEPOSITION.
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 5B.
W91-03293

SEQUENTIAL PRECIPITATION SAMPLERS: A LITERATURE REVIEW.
Nebraska Univ. at Omaha. Dept. of Chemistry.
F. C. Laquer.
Atmospheric Environment Part A: General Topics AEATEN, Vol. 24, No. 9, p 2289-2297, September 1990. 1 tab, 114 ref.

Descriptors: *Instrumentation, *Literature review, *Meteorological data collection, *Precipitation, *Rain gages, *Sample preservation, *Sampling, Chemistry of precipitation, Design criteria, Monitoring, Precipitation scavenging, Trace analysis.

The literature of sequential or within-event precipitation sampler construction and applications is reviewed. Collection devices are classified as manually segmenting samplers, linked collection vessels, automatically segmenting samplers and continuous monitors. The rainfall collectors have in common a large surface area to collect the precipitation and funnels commonly constructed from polyethylene or stainless steel. Early applications of sequential samplers were to determine radioactive fallout removal processes, and to monitor cloud seeding studies, below cloud scavenging and urban and precipitation scavenging studies. The collector design is highly dependent on the type of sample to be taken, i.e., major ions, trace metals, or organics. The collector should be covered to exclude dry deposition that would bias the sample. Deposition monitoring may use either sampling at unit times or at unit precipitation volumes. Precipitation scavenging research may sample by either method. Continuous monitoring or real time analysis of precipitation using a flow through collection system is dynamically attractive. It requires rapidly responding sensors, and a data collection system. The choice of chemical species to be measured determines how frequently the samples are transported to the laboratory. An alternative to immediate analysis is to trap the analyte, immediately converting it into a stable product. The number of samples and the volume to be taken depends on the chemical analysis to be performed. The collection surface for rainfall to be analyzed for the major inorganic ions may be plastic or stainless steel. When trace metals are to be determined in rainwater, the collection surface and sample bottle should be acid washed polyethylene or Teflon. Rainwater used for the determination of organic compounds should be collected on inert surfaces such as glass or stainless steel. Metal funnels can be more easily heated to melt snow than plastic funnels and may hold up better against the elements. The distance between the funnel and the sample container should be short to minimize particle losses to the tubing or other alterations of the sample. (Geiger-PTT)
W91-03294

INTERCOMPARISON OF CONTINUOUS FLOW, AND AUTOMATICALLY SEGMENTING RAINWATER COLLECTION METHODS FOR DETERMINING PRECIPITATION CONDUCTIVITY AND PH.
Nebraska Univ. at Omaha. Dept. of Chemistry.
F. C. Laquer.
Atmospheric Environment Part A: General Topics AEATEN, Vol. 24, No. 9, p 2299-2306, September 1990. 3 fig, 2 tab, 37 ref.

Descriptors: *Acid rain, *Conductivity, *Hydrogen ion concentration, *Instrumentation, *Precipitation, *Rain gages, *Sampling, Automation, Comparison studies, Electrodes, Performance evaluation, Precipitation intensity.

Two precipitation intensity or volume weighted rainwater collection methods, a continuous flow measuring device and a fraction collection system were compared during measurements of pH and conductivity of rainwater. The automatic fraction collector accumulated samples for later laboratory analysis at 0.2 mm intervals. The flow system measured rainwater conductivity and pH every 0.1 mm of rainfall. The flow system used a 60 cm diameter polypropylene funnel while the fraction system used a 40 cm diameter stainless steel funnel to collect the rainwater. Conductivity of the samples was measured in collected sequence using a dip cell. The pH of the fractions was measured using a pH electrode containing an annular ceramic junction recommended for rainwater measurements. Conductivity data from summer thunderstorms in Omaha, Nebraska, collected by the two systems were comparable to each other with integrated collection by a wet-only event collector. The conductivity of the rainwater in both the flow and the fraction systems rapidly decreased at the beginning of the rainfall and then increased at the end of the event. The flow system pH measurement exhibited bias with respect to the fraction collection system due to insufficient electrode equilibration time, especially when the precipitation conductivity was low (<10 microS/cm). (Geiger-PTT)
W91-03295

INTERACTION BETWEEN EQUILIBRATION PROCESSES AND WET OR DRY DEPOSITION.
California Inst. of Tech., Pasadena. Dept. of Chemical Engineering.
S. N. Pandis, and J. H. Seinfeld.
Atmospheric Environment Part A: General Topics AEATEN, Vol. 24, No. 9, p 2313-2327, September 1990. 9 fig, 20 ref. State of California Air Resources Board Agreement A932-054.

Descriptors: *Acid rain, *Aerosols, *Dry deposition, *Mathematical models, *Nitrogen compounds, *Path of pollutants, Deposition, Fog, Hydrogen peroxide, Nitric acid, Numerical analysis.

Three cases were examined to study the relationship between equilibration processes and deposition. The first case concerns a gas phase species A(g) that can be reversibly transferred to the aerosol phase as B(s). In the second case the gas-phase

species (e.g. HCHO, H2O2, O3) in the presence of droplets of liquid water content C is transferred reversibly to the aqueous-phase as B(aq). In the third case two gases A(g) and B(g) react to give a volatile aerosol AB(s), and in general all three species have different deposition velocities. This case is typified by the system of NH3(g), HNO3(g), and NH4NO3(s). Results of numerical analysis show that atmospheric equilibration processes between two phases with different deposition velocities have the potential to affect significantly the amount of total material deposited on the ground. The magnitude of the effects of the equilibration processes depends primarily on the ratio of the deposition velocities of the two phases, on the production/emission rate of the gas phase species, and on the initial distribution of species between the two phases. The deposition of a condensable species equilibrating between gas and aerosol phases can increase by as much as 20 times over that when equilibration processes are not present under gas-phase production rate) or to decrease by as much as 15 times (very small aerosol particles, most of the material initially in the gas phase and high gas-phase production rate). In fog episodes, the deposition of a gaseous species with a Henry's Law constant between 1,000 and 1,000,000 M/atm (e.g. SO2 for pH between 4.5 and 7, H2O2, HCHO etc.) can be enhanced by as much as a factor of 3 because of its transfer to the aqueous phase. For the NH3-HNO3-NH4NO3 system the total deposition can be reduced by as much as a factor of 3 for typical conditions in a polluted atmosphere and small initial concentration of aerosol NH4NO3 with NH3 initially dominating HNO3 in the gas phase. If an operator splitting scheme is used in a mathematical model both equilibration and removal processes should be included in the same operator or very small operator time steps (typically less than 1 min) will be necessary. (Geiger-PTT)
W91-03297

NUMERICAL SIMULATION OF WET SCAVENGING OF AIR POLLUTANTS: I. MODELING OF SEQUENTIAL PRECIPITATION RATES AT THE GROUND.
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W91-03298

NUMERICAL SIMULATION OF WET SCAVENGING OF AIR POLLUTANTS: II. MODELING OF RAIN COMPOSITION AT THE GROUND.
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W91-03299

PRINCIPAL COMPONENT ANALYSIS OF THE LAMB CATALOGUE OF DAILY WEATHER TYPES: PART 2, SEASONAL FREQUENCIES AND UPDATE TO 1987.
University of East Anglia, Norwich (England). Climatic Research Unit.
K. R. Briffa, P. D. Jones, and P. M. Kelly.
International Journal of Climatology IJCLEU, Vol. 10, No. 6, p 549-563, September/October 1990. 9 fig, 4 tab, 7 ref. DOE Grant DE-FG02-89ER69017.

Descriptors: *Climatology, *Meteorology, *Principal component analysis, *Seasonal variation, *Weather patterns, Air temperature, Great Britain, Precipitation, Temporal distribution.

Principal component analysis is applied to seasonal weather-type frequencies from the Lamb Catalogue of Daily Weather Types for the British Isles. Four combinations of the major weather types are identified, which represent around 70% of the variance of the data set. The four generic combinations are indices of the balance between: the westerly and cyclonic types; the westerly and anticyclonic types; the cyclonic or anticyclonic and directional types; and the northerly and other directional types. The significant relationships between the seasonal components and temperature and rainfall are physically reasonable, reflecting changes in the character of the meridional flow and the frequency of cyclonicity and anticyclonicity. A pronounced change in the character of the synoptic circulation over the British Isles has occurred in recent decades. A decline in the frequency of westerly weather types has been compensated for by an increase in the frequency of pure cyclonic and anticyclonic types and, dependent on season, directional types. This development suggests greater variability in the atmospheric circulation and related climatic parameters. The westerly decline has not been as marked in autumn. In autumn, though, there has been a notable shift towards greater southerliness at the expense of northerly weather types. (Geiger-PTT)
W91-03393

CLIMATOLOGICAL CONTINGENCY PROBABILITIES OF CLOUDS.
Liverpool Univ. (England). Dept. of Geography.
A. H. Goodman, A. Henderson-Sellers, and K. McGuffie.
International Journal of Climatology IJCLEU, Vol. 10, No. 6, p 565-589, September/October 1990. 17 fig, 1 tab, 16 ref. Air Force Office of Scientific Research Grants AFOSR-87-0195 and AFOSR-87-0299.

Descriptors: *Climatology, *Clouds, *Probability distribution, *Regional analysis, Satellite technology, Weather data collections, Weather patterns.

The ideas surrounding contingency co-occurrence probabilities of cloud types are discussed with respect to two types of probability: first, that given a lower level cloud (L) there is also an upper level cloud (U), P(L-> U), and secondly the probability that given an upper cloud layer there is a lower cloud layer, P(U->L). Particular emphasis is placed on the fact that analyses to date have considered the frequency of observation of co-occurrence, not the potentially more useful, co-existence probability. From four separate months of global surface observations the P(L->U) was calculated as a function of lower level cloud amount on a global, regional, and individual station basis for (1) stratiform and altiform, and (2) stratiform and cirriform cloud type combinations. Global patterns of P(L->U) behavior are somewhat similar to regional patterns produced by previous work and are, on occasions, reproducible on a regional scale and, in some instances, by individual stations. Values of P(L->U) involving lower level overcasts are required in the calculation of the P(U->L) term, thus rendering climatological estimates of P(L->U) susceptible to biasing if an inappropriate value of P(L->U) for L = overcast is chosen. To demonstrate this effect, monthly global climatologies of P(U->L) were generated for several combinations of upper and lower cloud types using (1) an assumed mean value for the overcast case, and (2) a modification to the previously assumed overcast P(L->U) values, as suggested here. Comparison of these climatologies revealed differences, widely spread across the globe, of mostly within + or -10% according to cloud type, but with a few larger changes in excess of 30%. (Author's abstract)
W91-03394

CLIMATIC CLASSIFICATION FOR QUEENSLAND USING MULTIVARIATE STATISTICAL TECHNIQUES.
Jaffna Univ. (Sri Lanka). Dept. of Geography.
M. Puvaneswaran.
International Journal of Climatology IJCLEU, Vol. 10, No. 6, p 591-608, September/October 1990. 8 fig, 4 tab, 14 ref.

Descriptors: *Australia, *Climatology, *Multivariate analysis, *Rainfall, *Regional analysis, *Spatial distribution, Air temperature, Cluster analysis, Relative humidity, Statistical methods, Weather data collections.

An array of 28 climatic variables for 113 stations in Queensland, Australia, was subjected to factor analysis and cluster analysis to obtain an objective climatic classification for this region. The factor analytical approach elucidated three major factors from the matrix: a humidity factor, a temperature factor, and a rainfall factor. Spatial variation of factor scores was described and linear equations were compiled using the factor loadings that were significant. By grouping these factors scores with the aid of a distance-grouping technique, Queensland was classified into three major homogeneous climatic regions. A further 12 subclimatic regions were also identified. These regions were considerably different than Koppen's classification scheme and were determined solely by climatic factors and not external factors such as soil type and vegetation. (Author's abstract)
W91-03395

DROUGHT OVER ZIMBABWE IN A REGIONAL AND GLOBAL CONTEXT.
Department of Meteorological Services, Harare (Zimbabwe).
C. H. Matarira.
International Journal of Climatology IJCLEU, Vol. 10, No. 6, p 609-625, September/October 1990. 8 fig, 2 tab, 53 ref.

Descriptors: *Climatology, *Drought, *El Nino/Southern Oscillation, *Meteorology, *Rainfall, *Regional analysis, *Zimbabwe, Cyclones, Meteorological data, Seasonal variation.

Meteorological conditions that lead to dry and wet episodes over Zimbabwe were examined by correlation analyses between the Southern Oscillation Index and rainfall over south-eastern central Africa. The results showed significant correlation between the Southern Oscillation (SO) and seasonal rainfall over the region. The results also indicated that the SO signal was stronger over the southeast of Zimbabwe and along the coastal areas of Mozambique. El Nino events seemed to be associated with below normal rainfall over Zimbabwe, while cold events, which were the opposite extreme of the SO, were accompanied by above average rainfall. Three-month seasonal (December-February) deviations of 1000-millibar temperature, surface pressure, and the 500-millibar geopotential height from the long-term mean were analyzed during wet periods and towards the ocean area during dry episodes. A similar pattern was observed at the 500-millibar level. A comparison of wet and dry seasons in relation to the temperature anomaly field pointed to an association between warmer 1000-millibar surface temperatures around the African subcontinent and above normal seasonal rainfall. Correlation analysis showed that a high incidence of tropical cyclones in the Mozambique Channel was associated with below normal rainfall over Zimbabwe. (Author's abstract)
W91-03396

REGIONALITY AND PERIODICITY OBSERVED IN RAINFALL VARIATIONS OF THE BAIU SEASON OVER JAPAN.
Tsukuba Univ. (Japan). Inst. of Geoscience.
A. Murata.
International Journal of Climatology IJCLEU, Vol. 10, No. 6, p 627-646, September/October 1990. 15 fig, 3 tab, 37 ref.

Descriptors: *Climatology, *Japan, *Meteorology, *Rainfall, *Regional analysis, *Seasonal variation, Principal component analysis, Temporal distribution.

The regionality of rainfall variations of the Baiu, a rainy season over Japan, was investigated with special reference to periodicity. Using the Varimax rotated principal component analysis (PCA), Japan was divided into eight regions based on natural-logarithm-transformed rainfall data of June. In order to find significant rainfall variations from a sequence of rainfall data in each region, non-rotated PCA was applied to the rainfall data for each region. Its first component score was defined as the rainfall variation index (RVI). Four regions showed statistically significant periodicities of 10, 8, 4, or 2.2 yr in rainfall variations. In addition, the rainfall variations revealed a similarity in the general shapes of spectral density for each region. The temporal variations of each periodicity showed non-stationary changes. This feature was especially distinct for periodicities at 4 and 2.2 yr. From the

results of squared coherence, it was shown that these periodicities are closely related to variations of the North Pacific High and the Okhotsk High air masses. The validity of the regional division proposed in the present study was confirmed in comparison with other studies. Analysis of correlation coefficients between rainfall amounts and rainfall variation indices during the Baiu rainy season indicated that rainfall variations in June and July displayed satisfactory seasonal representativity. (Author's abstract)
W91-03397

THEORETICALLY DERIVED DISTRIBUTION FOR ANNUAL RAINFALL TOTALS.
K. J. A. Revfeim.
International Journal of Climatology IJCLEU, Vol. 10, No. 6, p 647-650, September/October 1990. 2 tab, 8 ref.

Descriptors: *Meteorology, *Model studies, *Rainfall, *Statistical analysis, Synoptic analysis, Theoretical analysis.

Rainfall occurs as synoptic events, and in many climates annual totals are made up of a moderate to large number of events of varying amounts. Assumption of an underlying Poisson process of event occurrence leads to a simple statistical density, in terms of physically meaningful parameters for the fourth root of annual totals. Analysis of data for four locations (Milan, Italy, Stensele and Kristianstad, Sweden, and Kelburn, New Zealand) gave estimates of event-recurrence rates in agreement with the number of rain-days in the local climates. The density factor for the fourth root of annual rainfall totals may be useful for discriminating between rainfall totals in regimes such as El Nino/La Nina when the distributions are less well represented by overlapping Guassian forms. This analysis complements the compound Poisson distribution which is a realistic model for monthly or other short-term totals. (Author's abstract)
W91-03398

COMPUTED NORMAL RANGE OF IOWA STATEWIDE JULY PRECIPITATION.
Iowa State Univ., Ames. Dept. of Agronomy.
H. C. Vaughan, D. S. Sheets, and G. R. White.
Journal of the Iowa Academy of Science JIASEB, Vol. 97, No. 3, p 91-97, September 1990. 10 fig, 1 tab, 5 ref.

Descriptors: *Climatology, *Iowa, *Meteorological data, *Meteorology, *Precipitation, *Rainfall distribution, Distribution patterns, Moisture deficiency, Rainfall area, Seasonal variation, Standard deviation, Statistical analysis.

Iowa summer rainfall distributions were examined to identify small-scale anomalies. Examination of extremely wet and dry summer months showed that large rain amounts fall mainly in small, cellular areas for both extremely wet and dry months. These configurations result from individual rainfall events. Analysis of the distribution of mean July rainfall across the state revealed significant anomalous wet and dry regions that contrast with the background, east-west rainfall gradient. Because of the skewed nature of summer rainfall distributions, the median value was used to represent a more realistic expected rainfall amount for any given year. Some parts of the state had a more variable distribution and were more sensitive to the expected annual swing of one standard deviation. On the basis of statistical probabilities, these areas can expect summers of more severe moisture deficiencies to occur more often than in the rest of the state. (Author's abstract)
W91-03428

IMPACT OF GLOBAL WARMING AND COOLING ON MIDWESTERN AGRICULTURE.
Iowa State Univ., Ames. Dept. of Agronomy.
For primary bibliographic entry see Field 5C.
W91-03429

ATMOSPHERIC RESPONSE TO 1988 DROUGHT CONDITIONS AND FUTURE CLIMATE IMPLICATIONS.
Iowa State Univ., Ames. Dept. of Agronomy.
M. D. McCorcle.
Journal of the Iowa Academy of Science JIASEB, Vol. 97, No. 3, p 84-87, September 1990. 6 fig, 10 ref. Iowa Agriculture and Home Economics Experiment Station Project 2804.

Descriptors: *Agricultural hydrology, *Climatic changes, *Climatology, *Drought effects, *Global warming, *Iowa, *Meteorology, *Precipitation, *Weather forecasting, Air temperature, Atmospheric circulation, Drought, Greenhouse effect, Model studies, Rainfall distribution, Soil moisture.

Plentiful precipitation in the central United States is one of the basic components of the successful agricultural industry in the Corn Belt. A combination of moisture, wind, and topographic factors creates an ideal condition for rainfall over most of the region during the late spring and early summer. In 1988, many ingredients necessary for wet weather were absent. The region experienced a drought unequalled since the 1930s. The drought of 1988 demonstrated that the symptom of drought, namely, dry soils, can exacerbate and even perpetuate drought conditions by decreasing available moisture, altering circulation patterns vital to storm development, and increasing air temperatures. Models that predict future climate change, forecast that dry conditions, such as those in 1988, will become more prevalent in the future 'greenhouse' atmosphere of the central United States. Many of the smaller-scale effects, which were important in perpetuating the drought of 1988, could not be anticipated from these poor-resolution climate models. Therefore, great care should be taken in interpreting these forecast results. (Author's abstract)
W91-03430

CLIMATE CHANGE AND THE POTENTIAL IMPACT ON THE SOIL RESOURCE.
Agricultural Research Service, Ames, IA.
J. L. Hatfield.
Journal of the Iowa Academy of Science JIASEB, Vol. 97, No. 3, p 82-83, September 1990. 15 ref.

Descriptors: *Agriculture, *Climatic changes, *Global warming, *Hydrologic cycle, *Soil management, *Soil water, Air temperature, Atmosphere, Atmospheric chemistry, Greenhouse effect, Nutrients, Precipitation, Resources management, Water use efficiency.

Climatic change will lead to changes in atmospheric carbon dioxide concentrations, temperature, and precipitation. There have been many predictions of the effect of climatic change on plant growth, but none on soil parameters or water use. To fully understand the implications of climatic change on soil management, the expected changes in soil temperature, water use, and water and nutrient use efficiency need quantification. The agricultural community is concerned today about sustainable agriculture. One of the key variables in sustainable agriculture systems is the soil. A changing climatic regime dictates that we understand how the parameters affecting the soil interface with a sustainable agriculture system. (Fish-PTT)
W91-03431

FACTORS ASSOCIATED WITH DISTRIBUTION OF RAINFALL IN THE GALILEE, ISRAEL.
Haifa Univ. (Israel). Dept. of Geography.
H. Kutiel.
Pirineos: Revista de Ecologia de Montana PRNOAJ, Vol. 134, p 41-58, 1989. 8 fig, 5 tab, 15 ref.

Descriptors: *Hydrologic models, *Israel, *Orography, *Rainfall distribution, *Regression analysis, Altitude, Latitudinal studies, Orographic precipitation, Spatial distribution.

Monthly totals from 30 stations in the Galilee, Israel, for 20 rainfall seasons (1960/61-1979/80) were regressed against the longitude, the latitude, and the altitude of the stations. The distribution of the order of entrance into the multiple regression model of the different independent variables resembles previous results for averaged data over the entire period. The results highlight a coherent period in terms of similar factors affecting the spatial rainfall distribution during February and March. Despite the fact that the orography is the main factor affecting the spatial rainfall distribution in the Galilee, during extremely wet periods (months or seasons) the spatial distribution is related more to the distance from the sea than to the altitude. (Author's abstract)
W91-03434

PRECIPITATION CHEMISTRY: ATMOSPHERIC LOADINGS TO THE SURFACE WATERS OF THE INDIAN RIVER LAGOON BASIN BY RAINFALL.
Bionetics Corp., Cocoa Beach, FL.
For primary bibliographic entry see Field 2K.
W91-03440

EFFECT OF AIR POLLUTION CHEMICAL COMPONENTS ON THE ACIDITY OF RAIN WATER IN JAPAN.
Kobe Women's Coll. of Pharmacy (Japan).
For primary bibliographic entry see Field 5B.
W91-03464

USE OF COOPERATIVE WEATHER STATION DATA IN CONTEMPORARY CLIMATE RESEARCH.
Illinois State Water Survey Div., Champaign. Climate and Meteorology Section.
P. J. Lamb, and M. B. Richman.
Transactions of the Illinois Academy of Science TISAAH, Vol. 83, No. 1/2, p 70-81, 1990. 5 fig, 17 ref. NSF Grants ATM 83-12653 and 85-20877.

Descriptors: *Climatic data, *Climatology, *Meteorological data collection, *Precipitation mapping, *Weather data collections, Canada, Climatic changes, Correlation analysis, Networks, Prediction, Regional analysis, Spatial distribution.

Daily precipitation observations made at thousands of cooperative weather stations in the central U.S. and southern Canada during the May-August periods of 1949-1980 were distilled into a set for a grid-like network of 557 locations which were used to delineate areas of spatial precipitation coherence for a range of time scales and periods. This delineation was achieved by applying a variety of eigenvectorial techniques and correlation analysis to network station totals for 3, 7, 15, 30, 41, and 61 day periods. All analyses were performed for May-August as a whole; those for 3 day periods were also conducted on a half-monthly basis. The resulting regionalizations of the vast study domain into smaller areas of precipitation coherence were compared. The regionalizations seem particularly relevant to the predictive crop yield modeling that is now routinely performed for the growing season of the central U.S.; modelers are uncertain about the number, morphology, and spatial representativeness of the regions for which individual models should be utilized. Because the regionalizations also hold for the 3 day time scale, they may also have utility for the 48-96 hour prediction of precipitation. A related potential application is in studies of climatic change over the last 100-150 years. The spatial variation in the extent to which the 3-7 day regionalization changes as the precipitation totalling period is extended to 15, 30, 41, and 61 days provides a framework for investigating how short-period weather variations integrate to climate fluctuations. This study illustrates the great value of the voluntary observers who operated the cooperative weather stations. (Author's abstract)
W91-03503

IMPACT OF SEA SURFACE TEMPERATURE ANOMALIES ON THE RAINFALL OVER NORTHEAST BRAZIL.
California Univ., Los Angeles. Dept. of Atmospheric Sciences.
C. R. Mechoso, S. W. Lyons, and J. A. Spahr.
Journal of Climate JLCLEL, Vol. 3, No. 8, p 812-826, August 1990. 16 fig, 18 ref.

Descriptors: *Climatology, *Meteorology, *Temperature effects, *Water temperature, *Weather patterns, Atlantic Ocean, Marine climates, Northern Hemisphere, Pacific Ocean, Precipitation, Sea breezes, Weather, Wind.

The response of the tropical atmosphere to the sea surface temperature anomalies in the Northern Hemisphere spring of 1984 was investigated. The methodology for investigation consisted of comparing simulations with and without the global distribution of sea surface temperature anomalies in the boundary conditions of the UCLA General Circulation Model. At low levels, the response included weaker southeast trade winds over the Atlantic, increased precipitation off the northeast coast of Brazil, and reduced precipitation west of this region. The increased precipitation was due to enhanced convergence of moisture advected by the southeast trade winds, although the trades themselves were weaker. The results of the western equatorial Atlantic were in apparent agreement with the observed anomalous southern migration of the ITCZ in years with warm sea surface anomalies in the southern tropical Atlantic. There were strong anomalous trade winds over the Pacific extending east of the date line and weak wind anomalies over the maritime continent, in broad agreement with the observed. The sensitivity of the simulated atmospheric response over an ocean basin to using the sea surface temperature anomalies confined to the basin or in the global ocean was analyzed. It was found that there could be notable local differences in the results obtained using those procedures. In particular, the simulation with the sea surface temperature anomalies confined to the Pacific showed weak anomalous trade winds over the western part of this ocean basin and strong westerly anomalies over the maritime continent unlike that with the anomalies in the global ocean. (Author's abstract)
W91-03522

SEA LEVEL AND RAINFALL CORRELATIONS IN AUSTRALIA: TROPICAL LINKS.
Flinders Inst. for Atmospheric and Marine Sciences, Bedford Park (Australia).
R. J. Allan, K. Beck, and W. M. Mitchell.
Journal of Climate JLCLEL, Vol. 3, No. 8, p 838-846, August 1990. 5 fig, 60 ref.

Descriptors: *Australia, *Climatology, *El Nino/Southern Oscillation, *Meteorology, *Rainfall distribution, *Sea level, Seasonal variation, Temperature effects, Water temperature, Weather patterns, Wind.

A preliminary study was made of simultaneous and lagged seasonal cross correlations between northern Australian sea level and district rainfall anomalies. Zero-lagged patterns showed strong links with the El Nino/Southern Oscillation phenomenon over northern and eastern Australia during austral winter-spring seasons. These findings were similar to, but more robust than, those reported for simultaneous cross correlations between Australian district rainfall and either the southern oscillation index. Darwin mean sea level pressure, or northern Australian seas surface temperatures. This appeared to be a consequence of the strong integrating response of northern Australian sea levels, particularly to inverse barometric and wind forcings on seasonal time scales. Such relationships were explored further in lagged cross correlations. As observed in other studies of seasonal persistence associated with El Nino/Southern Oscillation and anti-El Nino/Southern Oscillation phases, rainfall precursors extend in time from one to two seasons. However, significant seasonal cross correlations were found at longer intervals, reflecting the marked sea level response to the often observed anti-El Nino/Southern Oscillation to El Nino/Southern Oscillation sequence of the phenomenon. In particular, austral spring sea levels in northern Australia were negatively correlated with the following austral winter rainfall over parts of northern and south-southeastern Australia. At present an operational evaluation of precursors must await the installation of new telemetering tide gauges in northern Australian ports. (Author's abstract)
W91-03523

EIGHT-MONTH SAMPLE OF MARINE STRATOCUMULUS CLOUD FRACTION, ALBEDO, AND INTEGRATED LIQUID WATER.
Pennsylvania State Univ., University Park. Dept. of Meteorology.
C. W. Fairall, J. E. Hare, and J. B. Snider.
Journal of Climate JLCLEL, Vol. 3, No. 8, p 847-864, August 1990. 16 fig, 1 tab, 28 ref. NASA grant NAG 1-652.

Descriptors: *Albedo, *Cloud cover, *Cloud liquid water, *Meteorological data collection, *Meteorology, Clouds, Data collections, Irradiation, Weather.

As part of the First International Satellite Cloud Climatology Regional Experiment, a surface meteorology and shortwave/longwave irradiance station was operated in a marine stratocumulus regime on the northwest tip of San Nicolas Island off the coast of Southern California. Measurements were taken from March through October 1987, including a First International Satellite Cloud Climatology Regional Experiment Intensive Field Operation held in July. Algorithms were developed to use the longwave irradiance data to estimate fractional cloudiness and to use the shortwave irradiance to estimate cloud albedo and integrated cloud liquid water content. Cloud base height is estimated from computations of the lifting condensation level. The algorithms are tested against direct measurements made during the Intensive Field Operation; a 30% adjustment was made to the liquid water parameterization. The algorithms were then applied to the entire database. The stratocumulus clouds over the island were found to have a cloud base height of about 400 m, an integrated liquid water content of 75 g/sq m, a fractional cloudiness of 0.95, and an albedo of 0.55. Integrated liquid water content rarely exceeds 350 g/sq m and albedo rarely exceeds 0.90 for stratocumulus clouds. Over the summer months, the average cloud fraction shows a maximum at sunrise of 0.74 and a minimum at sunset of 0.41. Over the same period, the average cloud albedo shows a maximum of 0.61 at sunrise and a minimum of 0.31 a few hours after local noon (although the estimate is more uncertain because of the extreme solar zenith angle). The use of joint frequency distributions of fractional cloudiness with solar transmittance or cloud base height to classify cloud types appears to be useful. (Author's abstract)
W91-03524

PREDICTION OF NORTHEAST BRAZIL RAINFALL ANOMALIES.
Wisconsin Univ.-Madison. Dept. of Meteorology.
S. Hastenrath.
Journal of Climate JLCLEL, Vol. 3, No. 8, p 893-904, August 1990. 6 fig, 5 tab, 21 ref. NSF grant ATM-8722410.

Descriptors: *Climatology, *Meteorology, *Rainfall index, *Weather forecasting, Brazil, Data collections, Meteorological data collection, Precipitation, Rainfall, Seasonal variation, Temperature effects, Water temperature.

Expanding on earlier research, empirically based methods were developed for predicting March-September rainfall in northern Northeast Brazil. From a network of 27 raingage stations in Brazil's Nordeste, new rainfall index series were constructed for March-September and October-January. Data input to stepwise multiple regression models further included January values of the Tahiti minus Darwin pressure index, an index of sea surface temperature in the equatorial Pacific, and indices of the fields of meridional and zonal wind components and of sea surface temperature in the tropical Atlantic between 30 deg N and 30 deg S. Empirical orthogonal function analysis of the meridional and zonal wind components and sea surface temperature fields was used in construction the latter three indices. Throughout the study, a sharp distinction was kept between a dependent dataset (1921-42 and 1948-57) used as a training period and an independent portion of the record (1958-87) reserved for prediction experiments. Preseason rainfall was by far the most powerful predictor, allowing 52% of the interannual March-September variance in an independent dataset to be forecast. From experiments with unrestricted data input, a model with the predictors October-January, indices of the field of meridional wind components, and the index of sea surface temperature in the equatorial Pacific showed the best performance, capturing 71% of the March-September variance in the independent dataset. Experiments on the optimal length of the training period suggest that one of 20-30 years was adequate. Updating offers no advantage over a fixed training period. For the purposes of operational application, the maintenance and timely processing of raingage measurements was of paramount importance. The next important task, demanding considerably greater resources, would be the real-time monitoring of the surface wind field over the tropical Atlantic. (Author's abstract)
W91-03525

COMPUTATION OF THE INSTANTANEOUS UNIT HYDROGRAPH AND IDENTIFIABLE COMPONENT FLOWS WITH APPLICATION TO TWO SMALL UPLAND CATCHMENTS.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
For primary bibliographic entry see Field 2E.
W91-03553

GREAT STORM OF 15/16 OCTOBER 1987: PASSIVE MICROWAVE EVALUATIONS OF ASSOCIATED RAINFALL AND MARINE WIND SPEEDS.
Bristol Univ. (England). Dept. of Geography.
E. C. Barrett, C. Kidd, J. O. Bailey, and C. G. Collier.
Meteorological Magazine MTMGA5, Vol. 119, No. 1418, p 177-187, September 1990. 7 fig, 2 tab, 22 ref.

Descriptors: *Data acquisition, *Meteorology, *Microwaves, *Rainfall, *Satellite technology, *Storms, *Wind velocity, England, Meteorological data, Microwave imagery, Rainfall distribution, Rainfall rate, Weather patterns.

Analyses of the Special Sensor Microwave Imager (SSM/I) data for the British Isles and surrounding waters from 15-16 October 1987 were performed. SSM/I carried by current US military meteorological satellites has proven capabilities for the evaluation of several weather-related parameters, including instantaneous rain areas and rain rates, and marine wind speeds. The highest wind speeds appeared in the Bay of Biscay, reaching over 61 kn in places, for the storm of 15-16 October 1987. High speeds were evident in some windward coastal regions, including the west coast of France, the Strait of Dover, and even parts of the west coast of Norway. Application of an SSM/I rainfall algorithm indicated that instantaneous rain rates were as high as 64-128 mm/h southwest of Cornwall, and even higher over Spain. The SSM/I algorithm was successful in depicting the rain in areas beyond the limits of radar coverage. The percentage correspondence between FRONTIERS radar and microwave rain/no rain pixels was 80% for the period from 13 to 19 October, 1987. It is concluded that the SSM/I instrument has clear potential for the monitoring of both rainfall and wind speeds over the British Isles region, especially over water. (MacKeen-PTT)
W91-03559

HEAVY MESOSCALE SNOWFALL EVENT IN NORTHERN GERMANY.
For primary bibliographic entry see Field 2C.
W91-03560

USE OF OPERATIONAL 0-6 AND 3-9 H QUANTITATIVE PRECIPITATION FORECASTS FOR PREDICTING HEAVY RAIN EVENTS.
National Weather Service, Silver Spring, MD. Techniques Development Lab.
J. P. Charba, and J. T. Moeller.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-103946/AS. Price codes: AO3 in paper copy, AO1 in

microfiche. June 1989. 36p, 20 fig, 7 tab, 11 ref.

Descriptors: *Meteorology, *Precipitation, *Weather forecasting, Isohyets, Rainfall forecasting, Statistical analysis.

New 0-6 and 3-9 h objective quantitative precipitation forecasts (OBJ) for the coterminous United States have been recently implemented in the National Weather Service. The forecasts are issued in the form of isohyets of both the maximum point precipitation amount and the probability of equalling or exceeding specific amounts in 40 x 40 n mi boxes. After taking into account differences in the event forecast, the performance of the isohyetical maximum amounts were compared with manual and model-generated quantitative precipitation forecasts (QPF's) issued 2-12 h earlier from the National Meteorological Center (NMC). Results show the accuracy of the OBJ forecasts was substantially better than the longer range NMC QPF's, particularly for the heavier amounts. The utility of the OBJ probability forecasts was also considered. The probabilities exhibit good statistical reliability, particularly where sample sizes are adequate. Also, several examples of very heavy rainstorms indicate the probabilities can be used to express confidence in the predicted isohyets and to assess the overall magnitude of the precipitation event. It is concluded that the isohyetical OBJ forecasts are a useful update of other centralized QPF's and that the probabilities add a useful measure of confidence to the predicted isohyets. (Author's abstract)
W91-03576

CASE STUDY EVALUATION OF SATELLITE-DERIVED RAINFALL ESTIMATES AND THEIR APPLICATION TO NUMERICAL MODEL PRECIPITATION FORECAST VERIFICATION.
National Weather Service Forecast Office, Milwaukee, WI.
G. A. Field.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-194591/AS. Price codes: A05 in paper copy, A01 in microfiche. May 1989. 77p, 32 fig, 4 tab, 50 ref.

Descriptors: *Climatology, *Meteorology, *Precipitation mapping, *Satellite technology, *Weather forecasting, Model studies, Performance evaluation, Verification studies.

Satellite-derived precipitation estimates are computed and then evaluated using a dense network of cooperative observer rain gage reports as the verification. The satellite rainfall estimates are produced every half hour for the 24-hour period starting 1200 GMT, July 20, 1981. They are computed using the operational Scofield-Oliver Convective Rainfall Estimation Technique on the University of Wisconsin's Man-Computer Interactive Data Access System (McIDAS). The McIDAS analysis procedure provides estimate values assigned to grid points spaced 22 km apart. The rainfall observations, however, are at irregularly located positions. In order to be able to objectively evaluate the estimates, the observations are interpolated to the same grid points as the estimates using a minimum of smoothing. Difference fields then are evaluated. The numerical model evaluated is an Australian mesoscale model referred to as the Subsynoptic Scale Model (SSM). The results show that the satellite estimates compare very favorably with the observations, especially with regard to location of rainfall maxima. It is shown that the orientation of the maxima and minima axes in the contoured estimate field is in good agreement with the observations and radar reports. As would be expected, this agreement improves with higher amounts of smoothing. Some displacement errors are observed and it is shown how small location errors can lead to large errors in a gridded difference field. By using satellite estimates as part of the SSM model verification, this study suggests a new application for the use of the Scofield-Oliver technique. Unfortunately, the SSM model fails to accurately predict convective precipitation in this case study. It's forecast precipitation area is too far to the north and the amounts are much too small. Nevertheless, the feasibility of using satellite estimates to verify the model is demonstrated. It is shown that the potential exists for operational numerical (mesoscale) modeling to benefit by having such satellite verification information for precipitation which can be produced in near real-time. (Author's abstract)
W91-03600

DETERMINATION OF AN UPPER LIMIT DESIGN RAINSTORM FOR THE COLORADO RIVER BASIN ABOVE HOOVER DAM.
Morrison-Knudsen Engineers, Inc., Denver, CO.
Available from the National Technical Information Service, Springfield, VA. 22161 as PB91-104562. Price codes: A07 in paper copy, A07 in microfiche. September 1990. 129p, 82 fig, 30 tab, 44 ref, 2 append. Bureau of Reclamation Contract 5-CA-30-02880.

Descriptors: *Colorado River Basin, *Data interpretation, *Design storms, *Model studies, *Rainfall forecasting, *Rainfall rate, *Rainfall-runoff relationships, Computer programs, Glen Canyon Dam, Hoover Dam, Meteorology, Net rainfall, Orographic precipitation, Rainfall area, Simulated rainfall, Spatial distribution, Temporal distribution, Topography.

Storms over the Southern Intermountain Region were reviewed to determine the cause of large rainfall amounts for the May through October season. Rainfall amounts from the largest storms were analyzed using a Bureau of Reclamation mini-storm computer program to determine DAD (depth-area-duration) values. These DAD data formed the basis for the development of the magnitude of the ULDRS (Upper Limit Design Rain Storm) for the Colorado River Basin above Hoover Dam. For this basin, rainfall magnitude is influenced by topography, and an ULDRS magnitude is required for each storm centering. Review of the data from storms indicated that one storm centering on the San Juan Mountains was characteristic for the basin above Glen Canyon Dam. A storm centering on the Pine and Cedar Mountains was characteristic of the basin between Hoover and Glen Canyon Dams. The ULDRS magnitude was determined for these two locations with individual storm spatial and temporal distributions provided. The magnitude and time interval required for storms to recur at these locations was needed. Review of large storms over the basin indicated an interstorm interval increasing from 7 days in midsummer and fall to more than 10 days in the spring would permit the ULDRS to recur. Lesser events could occur with lesser time intervals. (Author's abstract)
W91-03664

TEMPORAL CHANGES IN HEAVY RAINFALL FREQUENCIES IN THE GREAT LAKES BASIN.
Illinois State Water Survey Div., Champaign.
F. Huff, and J. Angel.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 129-135, 4 fig, 3 tab, 6 ref.

Descriptors: *Great Lakes, *Illinois, *Lake management, *Rainfall distribution, *Water level fluctuations, *Water resources management, Climatic changes, Frequency analysis, Frequency distribution, Indiana, Lake Michigan, Michigan, Rainfall intensity, Spatial analysis, Wisconsin.

Analyses of heavy rainstorm data from 61 stations in Illinois during 1901-80 have indicated an increasing trend in the frequency distribution of heavy storms over most of the state since 1940. The increase has been most pronounced in northeast Illinois which borders on Lake Michigan. Evidence of a climatic fluctuation, exhibiting trends upward in the north and downward in the southern part of Illinois, was most evident in the comparison of frequency distributions derived from two 40-year samples and supported considerably by the 20-year trend analyses. Preliminary findings for other lake-bordering states indicate the Illinois high extends across the lake into southwest Michigan, eastward into northwest Indiana, and northward into southern and southeast Wisconsin. Thus, there is continuity in spatial patterns indicated, and a substantial increase in the frequency and intensity of heavy rainstorms is indicated in some portions of the lake-bordering states. These increases appear to be greater than expected from natural climatic variability, and sufficiently large to have implications in water structure designs. (See also W91-03672) (Author's abstract)
W91-03686

STOCHASTIC MODEL OF THE INTERNAL STRUCTURE OF CONVECTIVE PRECIPITATION IN TIME AT A RAINGAUGE SITE.
Universidad Politecnica de Valencia (Spain). Dept. of Hydraulic and Environmental Engineering.
R. Garcia-Bartual, and J. Marco.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 129-142, October 1990. 9 fig, 2 tab, 14 ref.

Descriptors: *Convective precipitation, *Hydrologic models, *Model studies, *Precipitation, *Rainfall intensity, *Statistics, *Stochastic models, *Storms, *Time series analysis, Algorithms, Probable maximum precipitation, Rain gages, Spain, Synthetic hydrology.

Analyses of stochastic structures of precipitation usually center on two distinct problems, the internal and external structures. Internal structure concerns the within-the-storm intensity, while external structure analyzes sequences of precipitation storms. Hyetographs of extreme convective precipitation were modeled in terms of a marked finite point process of convective cell arrivals, each point or occurrence in time representing the birth of a cell. Rain intensity resulting from the activity of each of these cells is assumed to have a gamma-type function shape with peak intensity and volume being random variables. The model has been tested with data from maximum storms during the period 1940-1985 at two sites on the Mediterranean coast of Spain: Valencia and Alicante. The proposed temporal structure showed good agreement with the observed series at the smaller scales (increments of 10 min), and the most characteristic temporal patterns in internal structure of precipitation were adequately described. Simple generation algorithms according to this formulation allow generation of synthetic series. (Author's abstract)
W91-03744

SAMPLING ERRORS FOR RAINGAUGE-DERIVED MEAN AREAL DAILY AND MONTHLY RAINFALL.
Hydrological Research Inst., Pretoria (South Africa).
A. W. Seed, and G. L. Austin.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 163-173, October 1990. 7 fig, 1 tab, 15 ref.

Descriptors: *Areal precipitation, *Convective precipitation, *Data interpretation, *Error analysis, *Meteorology, *Network design, *Rain gages, Meteorologic data, Parametric hydrology, Precision, Rainfall area, Variability.

The accuracy of rain gage derived mean areal rainfall needs to be understood before gage data can be used as ground truth for satellite and radar rainfall measuring systems. Radar data from two geographic locations were used to simulate the mean standard error in using a sparse rain gage network to estimate daily and monthly mean areal convective rainfall over areas ranging from 45,000 to 180,000 sq km. It was found that a network with a regular configuration gave somewhat less-variable errors than the random rain gage network, although the mean errors were very similar. The difference became more pronounced for the very sparse networks. The mean standard error for a particular network and rainfield was found to be a function of the number of gages in the network, the raining fraction of the area and the ratio of the standard deviation over the mean of the non-zero portion of the rainfield. A simple three-parameter relationship was proposed to relate the mean standard error, expressed as percentage of the mean areal rainfall, to these variables. It was found that a

single relationship was able to explain 63% of the variability in the estimated mean standard estimation error, combining data from both regions. Finally, the domain over which the relationship is able to make reasonable predictions is determined by the principle constraint of limiting the raining fraction of the area to 0.5 for networks with >200 rain gages. (Author's abstract) (Fish-PTT)
W91-03746

PARAMETER TRANSFERABILITY FOR A DAILY RAINFALL DISAGGREGATION MODEL.
National Weather Service, Johnson City, NY.
T. W. Econopouly, D. R. Davis, and D. A. Woolhiser.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 209-228, October 1990. 6 fig, 11 tab, 13 ref.

Descriptors: *Climatology, *Hydrologic models, *Local precipitation, *Model studies, *Parametric hydrology, *Rainfall, *Statistical analysis, Data interpretation, Rain gages, Simulation analysis, Stochastic models.

Methods that use readily-available daily rainfall data to stochastically simulate short-time period rainfall have been developed. At least two methods of disaggregating daily rainfall into shorter time periods exist in the literature: the discrete-discrete (D-D) and the discrete-continuous (D-C). The D-C method disaggregates the discrete daily rainfall process into a continuous process of wet periods (showers) and dry periods within a day, and appears to require fewer parameters than the D-D process. The D-C model was modified and applied to data from two midwestern stations in the U.S. Statistical tests indicate that the number of showers, the start times, shower depths, and shower durations of simulated sequences compare favorably with observed sequences, and that the disaggregation model parameters identified at one gage provide a satisfactory fit for three test stations up to 470 km away, provided the test stations are in the same climatological region. (Author's abstract)
W91-03749

INTERCEPTION, THROUGHFALL AND STEMFLOW IN A FOREST IN HIGHLAND SCOTLAND AND THE COMPARISON WITH OTHER UPLAND FORESTS IN THE U.K.
Institute of Hydrology, Balquhidder, Lochearnhead FK19 8PQ, Scotland.
For primary bibliographic entry see Field 2I.
W91-03753

INFLUENCE OF MOUNTAINS ON LARGE-SCALE PRECIPITATION: A DETERMINISTIC APPROACH TOWARDS OROGRAPHIC PMP.
Vienna Univ. (Austria). Inst. fuer Meteorologie und Geophysik.
T. Haiden, P. Kahlig, M. Kerschbaum, and F. Nobilis.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 5, p 501-510, October 1990. 5 fig, 1 tab, 18 ref.

Descriptors: *Areal precipitation, *Meteorology, *Mountains, *Orographic precipitation, *Probable maximum precipitation, *Rainfall forecasting, Austria, Cloud physics, Mathematical analysis, Mathematical models, Precipitation rate.

Probable maximum precipitation (PMP) is the greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of the year. This definition points to the importance of taking into account the synoptic and orographic boundary conditions for investigations of PMP. A physical approach was chosen to estimate orographic precipitation. Based on a balance equation for cloud water and on a kinematic model of air flow over mountains, the distribution of cloud water and precipitation rate is calculated for specified (but arbitrary) inflow conditions and orography. In contrast to comparable models in which the whole condensed water falls out, cloud physical parameters control the efficiency of precipitation formation. These results which concern the problems of precipitation enhancement by terrain-induced vertical motion are a first step toward new considerations regarding Probable Maximum Floods. For an alpine country like Austria, the development of a hierarchy of concepts, using deterministic model physics and a digital terrain representation, appear appropriate. A comparison of model results with observations using inflow data from measurements during actual precipitation episodes in Austria revealed basic similarities between observed patterns and the main structure of the simulated distribution. The basic features of the model are consistent extensions of WMO recommendations. (Hoskin-PTT)
W91-03841

COMPARISON OF OBJECTIVE AND SUBJECTIVE PRECIPITATION PROBABILITY FORECASTS: THE SUFFICIENCY RELATION.
Oregon State Univ., Corvallis. Dept. of Atmospheric Sciences.
A. H. Murphy, and Q. Ye.
Monthly Weather Review MWREAB, Vol. 118, No. 9, p 1783-1792, September 1990. 8 fig, 2 tab, 20 ref. NSF Grant ATM-8714108.

Descriptors: *Data interpretation, *Forecasting, *Meteorology, *Precipitation, *Precipitation forecasting, *Rainfall forecasting, *Weather forecasting, Comparison studies, Mathematical analysis, Probabilistic process.

The sufficiency relation is used to compare objective and subjective probability of precipitation (PoP) forecasts. The theoretical significance of the sufficiency relation in comparative evaluation arises from the fact that if it can be shown that forecasting system A is sufficient for forecasting system B, then A's forecasts are necessarily of higher quality and greater value to all users than B's forecasts. However, since the sufficiency relation is an incomplete order, the practical significance of this relation warrants further investigation. An operational method of comparing forecasting systems using the sufficiency relation has recently been described in the forecasting literature. This method involves the construction of a so-called forecast sufficiency characteristic (FSC) for each forecasting system, based on a representative set of forecasts and observations. In terms of this characterization, system A is sufficient for system B if A's FSC is superior to B's FSC. Objective and subjective PoP forecasts for six National Weather Service offices are compared in terms of their respective FSCs. Sufficiency was found in only two of the 24 cases defined by various combinations of forecast office, season, and lead time. In these two cases, both involving 12-24 hour forecasts, the subjective forecasts were sufficient for the objective forecasts. Several other cases exhibited a condition described as 'almost sufficient', but caution must be exercised in drawing conclusions regarding the relative quality and/or relative value of forecasts in such cases. Comparison of the FSCs of PoP forecasts and the FSCs of categorical forecasts derived from the PoP forecasts reveals that, as expected, the former are always superior to the latter. (Author's abstract)
W91-03850

SINGLE-DOPPLER OBSERVATIONS OF A WEST AFRICAN SQUALL LINE ON 27-28 MAY 1981 DURING COPT 81: KINEMATICS, THERMODYNAMICS AND WATER BUDGET.
Centre de Recherches en Physique de l'Environnement, Issy-les-Moulineaux (France).
For primary bibliographic entry see Field 7B.
W91-03851

EFFECTS OF CLIMATIC CHANGE ON THE THORNTHWAITE MOISTURE INDEX.
Geological Survey, Trenton, NJ.
G. J. McCabe, D. M. Wolock, L. E. Hay, and M. A. Ayers.
Water Resources Bulletin WARBAQ, Vol. 26, No. 4, p 633-643, August 1990. 11 fig, 1 tab, 18 ref.

Descriptors: *Air pollution effects, *Climatic changes, *Climatology, *Global warming, *Moisture index, *Precipitation, *Thornthwaite Moisture Index, *United States, Atmospheric chemistry, Atmospheric circulation, Carbon dioxide, Evapotranspiration, Meteorology, Model studies, Temperature effects.

The Thornthwaite moisture index is a useful indicator of the supply of water (precipitation) in an area relative to the demand for water under prevailing climatic conditions (potential evapotranspiration). The study examines the effects of changes in climate (temperature and precipitation) on the Thornthwaite moisture index in the conterminous United States. Estimates of changes in mean annual temperature and precipitation for double-atmospheric CO2 conditions derived from three general circulation models (GCMs) are used to study the response of the moisture index under steady-state doubled-CO2 conditions. Results indicate that temperature and precipitation changes under doubled-CO2 conditions generally will cause the Thornthwaite moisture index to decrease, implying a drier climate for most of the United States. The pattern of expected decrease is consistent among the three GCMs, although the amount of decrease depends on which GCM climatic-change scenario is used. Results also suggest that changes in the moisture index are related mainly to changes in the mean annual potential evapotranspiration as a result of changes in the mean annual temperature, rather than to changes in the mean annual precipitation. (Author's abstract)
W91-03858

VEGETATION AND CLIMATE OF THE LATE CAINOZOIC IN THE MURRAY BASIN AND THEIR BEARING ON THE SALINITY PROBLEM.
New South Wales Univ., Kensington (Australia). School of Biological Sciences.
For primary bibliographic entry see Field 2A.
W91-03903

2C. Snow, Ice, and Frost

LABORATORY STUDY ON THE SCAVENGING OF SO2 BY SNOW CRYSTALS.
Mainz Univ. (Germany, F.R.). Meteorological Inst.
For primary bibliographic entry see Field 5B.
W91-03296

COMPUTER SIMULATION OF ICE CONTROL WITH THERMAL-BUBBLE PLUMES: LINE SOURCE CONFIGURATION.
University of Western Ontario, London. Dept. of Civil Engineering.
R. E. Baddour.
Canadian Journal of Civil Engineering CJCEB8, Vol. 17, No. 4, p 509-513, August 1990. 8 fig, 19 ref.

Descriptors: *Channel maintenance, *Computer models, *Ice breakup, *Ice control, *Simulation analysis, Bubbles, Costs, Navigation channels, Obstructions to navigation, Thermal stratification.

Thermal-bubble plumes in a freshwater environment were studied to determine their ice control capabilities. A computer model was developed to optimize the operation of thermal-bubble installations when designed to control ice. Steady-state ice control simulations would be useful in determining feasible warm water-air combinations required to achieve a specified degree of ice control to maintain navigation channels. The availability and cost of providing warm water and air at the site would ultimately determine the optimal solution. It would generally be more economical to design a system to suppress ice growth and maintain a manageable thickness of ice, than to achieve large, fully open water conditions all the time. Warm water supply may not be required when natural stratification is present or during periods of mild weather. Transient ice control was simulated for the thermal bubbler and a regular bubbler for a 30 day period. The thermal bubbler gave superior ice control in the simulation analysis. Thermal bubble technology may also be applied to thermal and other industrial and municipal discharges into natural water bodies. (Geiger-PTT)

W91-03303

HEAT AND MASS BALANCE OF AN ABLATING ICE JAM.
National Hydrology Research Inst., Saskatoon (Saskatchewan). Northern Hydrology Section.
T. D. Prowse.
Canadian Journal of Civil Engineering CJCEB8, Vol. 17, No. 4, p 629-635, August 1990. 5 fig, 1 tab, 7 ref.

Descriptors: *Ablation, *Heat budget, *Ice breakup, *Ice jams, *Mathematical studies, Energy, Flood forecasting, Melting, Porosity, Rivers, Theoretical analysis, Water temperature.

The heat and mass balance of an ablating ice jam at the confluence of the Liard and Mackenzie rivers in the spring of 1983 was examined. From May 6 to May 9, sufficient data were collected to determine the magnitude and relative importance of the major heat fluxes that caused thermal decay of the ice jam. The total atmospheric heat input of 125 million MJ and the much larger contribution from hydrothermal sources of 980 million MJ resulted in a total melt of 32.4 million cu m of ice within the jam. These data in combination with previous results regarding jam dimensions permitted calculation of ice jam porosity, a variable frequently used in hydraulic studies of river ice jams although unverified by field data. The largest potential error in the calculations was related to the accuracy of water temperature measurement. Accounting for this resulted in an estimate of porosity of 0.38 + or -10% which lends credence to the commonly assumed value of 0.40. (Author's abstract)
W91-03310

PHOTOHETEROTROPHY AND DARK HETEROTROPHY IN ICE-COVERED LAKE ST. CLAIR.
Windsor Univ. (Ontario). Great Lakes Inst.
For primary bibliographic entry see Field 2H.
W91-03399

HEAVY MESOSCALE SNOWFALL EVENT IN NORTHERN GERMANY.
W. S. Pike.
Meteorological Magazine MTMGA5, Vol. 119, No. 1418, p 187-195, September 1990. 9 fig, 10 ref.

Descriptors: *Germany, *Meteorology, *Precipitation, *Snow, *Snow accumulation, *Storms, Air masses, Cyclones, Eddies, Hamburg, Local precipitation, Vortices, Weather, Weather patterns.

The geographical extent and particular causes of localized heavy snowfalls which occurred near southwest Baltic Sea coasts on the night of 11-12 January 1987 were investigated. A heavy snowfall of between 20 and 70 cm occurred in a 16-hr period along a narrow, sharply defined belt which was, geographically, an extension of the southern Mecklenburg Bight coastline downwind to the west-southwest towards southeastern Hamburg. The orientation of the coastline presented a shallow angle to the onshore wind which was extremely favorable for continuing coastal convergence and uplift between (1) a strong, moist, showery northeasterly airflow over the sea, with air temperatures typically -6 to -10 C, and (2) stagnating, colder overland air near -20 C. A well marked coastal front was formed between the two airflows. The formation of small Baltic Sea warm cyclones intensified the snowfall from time to time, in association with smaller eddy-vortices. The steep cliffs of Rugen Island also provide a natural topographic division of a cold northeasterly airstream, downwind of which the coastal convergence line is likely to form long a marked boundary between fast-flowing and slow-flowing airstreams at low levels. (MacKeen-PTT)
W91-03560

TRACING THE ORIGIN OF NATURAL WATERS IN A GLACIAL TILL SLOPE DURING SNOWMELT.
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Land and Water Resources.
B. Espeby.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 107-127, October 1990. 6 fig, 46 ref.

Descriptors: *Flow discharge, *Groundwater movement, *Isotopic tracers, *Oxygen isotopes, *Snowmelt, *Soil water, *Tracers, Chemical properties, Frozen ground, Interstitial water, Iodides, Leaching, Roots, Snow cover, Surface-groundwater relations, Sweden, Vadose zone, Water chemistry.

A study of the origin of water sampled at a set of sampling points in the discharging area of a sloping forested glacial till in Sweden, was performed during the two snowmelts of 1966 and 1987. Analyses of a limited number of chemical components and the oxygen-18 (O-18) content were performed of the sampled water from the snowmelt of 1986. A tracer experiment was performed during the snowmelt of 1987, when potassium iodide was sprayed on top of the snow cover at two surfaces in the discharging area of the slope. The results from both snowmelt studies indicate that macropore channels of old root remains can conduct water rapidly through an unsaturated and frozen matrix without displacing the soil-bound water. Alkalinity and pH values of the macropore water were similar to the snow cores. Even the deeper groundwater from a spring site was affected by the acid surge during the peak snowmelt of 1986, proving that macrostructures present in the till were promoting preferential water movement through the soil matrix. The surge was also detected with the O-18 technique but was not as pronounced as in the values of the chemical components. The tracer experiment gave these results despite the large amount of tracer that was retained in the unsaturated soil matrix. One very important conclusion from this experiment is that iodide should be injected below the humus and the leaching horizons of podsols in order to get good saturated conditions and thereby prevent retention in the matrix. (Author's abstract)
W91-03743

HYDRAULIC PROPERTIES IN AN OPERATIONAL MODEL OF FROZEN SOIL.
Uppsala Univ. (Sweden). Naturgeografiska Inst.
L. C. Lundin.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 289-310, October 1990. 10 fig, 1 tab, 42 ref.

Descriptors: *Frost, *Frozen ground, *Model studies, *Soil physical properties, *Soil water, Clays, Freezing, Hydraulic conductivity, Ice lenses, Impedance, Interstitial water, Loam, Soil moisture retention, Soil structure, Soil temperature.

Many current models of heat and water flow in frozen soils overestimate the freezing-induced redistribution of water. These models also treat the soil physical properties as constant in time although they are strongly influenced by the frost itself. A study was conducted to determine possible methods to overcome these two problems in an operational hydraulic model. Winter measurements of soil temperature and water content were performed on a clay soil and on a layered loam soil. The data were compared with simulations made with a physically-based, one-dimensional model of coupled heat and water flow. Two procedures were tested for the calculation of hydraulic conductivity of partially frozen soil: firstly, an interpolation procedure, taking into account the strong nonlinearity of the hydraulic conductivity function close to the freezing front. Secondly, an impedance parameter was used to describe the effect of ice lenses. A spring time modification of the soil moisture characteristic curve was tested to account for the frost-induced changes of the soil structure. Simulated temperatures and water contents agreed well with measurements, both for the clay and the layered loam soil, after introduction of the impedance parameter. The alternative procedure did not only reduce the hydraulic conductivity of the frozen soil sufficiently to produce a realistic redistribution, but also enabled use of a lower value on the impedance parameter. Changes in water retention properties resulting from frost action during winter caused an overestimation of simulated water content of 15% by volume in the heavy clay soil during spring. This discrepancy was eliminated by increasing the frequency of pore diameters below 0.1 mm in the model during spring. (Author's abstract)
W91-03754

EFFECTS OF CO 2-INDUCED CLIMATIC CHANGES ON SNOWPACK AND STREAMFLOW.
Agricultural Research Service, Boise, ID. Northwest Watershed Research Center.
For primary bibliographic entry see Field 4C.
W91-03842

COMPARISON OF DIFFERENT STRUCTURES FOR A MONTHLY WATER YIELD MODEL IN SEASONALLY SNOW-COVERED MOUNTAINOUS WATERSHEDS OF IRAN.
Katholieke Univ. Leuven (Belgium). Lab. for Land Management.
For primary bibliographic entry see Field 2E.
W91-03844

DYNAMICS AND ORIGIN OF SALINE SOILS ON THE SLIMS RIVER DELTA, KLUANE NATIONAL PARK, YUKON TERRITORY.
Calgary Univ. (Alberta). Dept. of Geography.
S. A. Harris.
Arctic ATICAB, Vol. 43, No. 2, p 159-175, June 1990. 13 fig, 12 tab, 67 ref, append.

Descriptors: *Deltas, *Frost, *Frozen soils, *Geochemistry, *Permafrost, *Saline soils, *Slims River, *Soil chemistry, *Yukon, Alaska, Leaching, Salinity, Seasonal variation, Snowmelt, Sulfates.

The saline soils of the Slims River Delta have developed on land formed in the last 100 years in an area of otherwise continuous permafrost. Deep seasonal frost on the delta prevents the downward leaching of salts when the snow melts. Instead, the salts accumulate at the surface as the ground dries, while additional salts are added from springs at the base of the surrounding mountains. Late summer rains can leach the soils if they are sufficiently heavy, producing a 3 to 4 fold variation in salinity from year to year. The efflorescences are dominated by the hexahydrate of magnesium sulfate, and the high sulfate content is probably the reason that soils in depressions with the morphology of solonetzic soils remain reasonably friable. The distribution of the characteristic halophytic plant association found on these soils appears to be controlled more by soil moisture content than by actual salinity level. (Author's abstract)
W91-03865

MOVEMENT OF CRUDE OIL IN AN EXPERIMENTAL SPILL ON THE SEEDS SIMULATED PIPELINE RIGHT-OF-WAY, FORT NORMAN, N.W.T.
Alberta Univ., Edmonton. Dept. of Geography.
For primary bibliographic entry see Field 5B.
W91-03866

WINTER SHORT-PULSE RADAR STUDIES ON THE TANANA RIVER, ALASKA.
Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 7B.
W91-03868

2D. Evaporation and Transpiration

SIMULATION OF DIURNAL TRANSPIRATION FROM WILLOW STANDS.
Gdansk Technical Univ. (Poland). Inst. of Hyrdotechnics.
For primary bibliographic entry see Field 2I.
W91-03200

WILLOW STAND EVAPORATION: SIMULATION OF DIURNAL DISTRIBUTION USING SYNOPTIC WEATHER DATA.

Uppsala Univ. (Sweden). Dept. of Hydrology.
For primary bibliographic entry see Field 2I.
W91-03201

MECHANISM OF EVAPORATION FROM SAND COLUMNS WITH RESTRICTED AND UNRESTRICTED WATER TABLES USING DEUTERIUM UNDER TURBULENT AIR-FLOW CONDITIONS.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
E. Shimojima, A. A. Curtis, and J. V. Turner.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 15-54, September 1990. 19 fig, 1 tab, 20 ref.

Descriptors: *Air-earth interfaces, *Deuterium, *Evaporation, *Sand, *Soil columns, *Water table, Air circulation, Evaporation rate, Isotope studies, Microdistillation, Turbulent flow, Water vapor.

Evaporation experiments from sand columns with restricted and unrestricted water tables were carried out to elucidate the mechanism of evaporation from bare land. Turbulent airflow was applied to the exposed surface layer. The transient development of the deuterium composition of liquid water in the sand columns was measured by a microdistillation technique during the experiments. Turbulent airflow affected the evaporative process of water vapor transfer and the deuterium distribution at relatively shallow depths in the columns. The attainment of a steady evaporation rate and deuterium profile was not obtained in either the restricted or unrestricted water table cases until significant time had elapsed. In the unrestricted water table case, the transient processes of evaporation rate, depth of the evaporation front, water table depth and the development of the deuterium concentration profile show a characteristic behavior that may be described by a similarity solution for part of the experimental duration. Significant enrichment of deuterium occurs in the liquid-vapor region and at the upper zone of the liquid region with time. The isotopic enrichment does not affect the physical process of evaporation of liquid water. Information on the transient development of the deuterium concentration profile is very useful for understanding the nature of liquid water and water vapor movement in the columns, and estimation of the depth of the evaporating front is an important index in bare land evaporation. (Author's abstract)
W91-03541

EXAMINING EVAPOTRANSPIRATION IN A SEMI-ARID REGION USING STABLE ISOTOPES OF HYDROGEN AND OXYGEN.
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Water Resources.
C. D. Walker, and J. P. Brunel.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 55-75, October 1990. 10 fig, 39 ref.

Descriptors: *Australia, *Evapotranspiration, *Isotope studies, *Isotopic tracers, *Semiarid lands, *Tracers, *Vegetation effects, Atmospheric water, Deuterium, Diffusion, Eucalyptus trees, Evaporation control, Leaves, Oxygen isotopes, Soil water, Water vapor.

Daily variation of the isotopic composition, both deuterium and oxygen-18, of water in foliage of a mixed eucalyptus 'mallee' community was studied in relation to the isotopic composition of soil water and atmospheric water vapor, transpiration and evapotranspiration, and environmental conditions. The isotopic composition of water in foliage and the soil surface were enriched over adjacent stem and deeper soil water respectively, characteristic of water subject to evaporation. The composition of foliar water varied systematically over the day, being highest in the late afternoon, in response to lower relative humidity. The foliar water composition fitted a steady-state model of leaf water fractionation. It was found that the fraction of leaf water equilibrated with the atmosphere was at a minimum during the middle of the day, fitting earlier observations. The equilibrated fraction was relatively high compared with previous transpiration studies. The soil water isotope-depth profiles had not achieved steady state. Using existing models, we conclude that the foliage and soil compartments are exchanging water vapor, but that some complicated evaporation processes are occurring in the soil, probably as a result of daily temperature cycling. Examining the relationship of the two isotope tracers in the different compartments, the vapor transport fits a transport model in which it is strongly diffusion-limited, both within the soil and leaf. Because of some uncertainty as to the transport mechanisms involved, it is not clear what the relative contributions from soil and foliage are. The vegetation may be having a considerable influence on the total evaporation from the community, since the effects of the root system on the soil structure and soil water transport are not clear. (Author's abstract)
W91-03740

WATER BALANCE OF SNOW TUSSOCK GRASSLAND IN NEW ZEALAND.
Otago Univ., Dunedin (New Zealand). Dept. of Geography.
D. I. Campbell, and D. L. Murray.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 229-245, October 1990. 8 fig, 4 tab, 18 ref.

Descriptors: *Evapotranspiration, *Grasslands, *Hydrologic budget, *New Zealand, *Vegetation effects, *Water yield, Clouds, Drainage, Evaporation, Fog, Forests, Interception loss, Leaves, Lysimeters, Pastures, Precipitation, Rainfall, Storage capacity, Storms, Transpiration, Watersheds.

The water relations of snow tussock grassland have been debated for many years although there are no published catchment comparisons of pasture and tussock vegetation. Measurements of rainfall, drainage, and weight change of a 6-sq-m surface area cylindrical lysimeter containing nine snow tussocks, were combined in a simple water balance equation to calculate evaporation on an hourly basis for 16 months in Otago, New Zealand. For most of the period it was possible to distinguish evaporation from dry foliage (transpiration), and wet canopy evaporation (interception loss), on the basis of leaf wetness. Mean daily transpiration rates ranged from 0.55 mm/day in June to 3.32 mm/day in January; intercepted water evaporated at a median rate of 0.04 mm/h in winter and on summer nights, and 0.08 mm/h during daylight in summer. Interception storage capacity is about 0.5 mm but relative interception losses are high when there are many small rain events. Horizontal interception of water from fog or cloud contributed about 1% of precipitation for the period examined. For the April-March year, total evaporation was 622 mm and transpiration exceeded interception loss in each month. Annual interception loss was 222 mm, or 21.3% of the total precipitation of 1042 mm. Monthly interception loss varied between 10% and 45% of precipitation and was very dependent on storm size and frequency. Snow tussock may be the optimal vegetation for water yield in this environment: transpiration rates are lower than for pasture and interception losses are less than for forests. (Author's abstract)
W91-03750

PALAEOHYDROGEOLOGY OF THE SENEGAL SEDIMENTARY BASIN: A TENTATIVE EXPLANATION OF THE PIEZOMETRIC DEPRESSIONS.
Ecole Inter-Etats d'Ingenieurs de l'Equipement Rural, Ouagadougou (Burkina Faso).
For primary bibliographic entry see Field 2F.
W91-03758

COMPARISON OF MODELS PREDICTING GROUND WATER LEVELS ON HILLSIDE SLOPES.
Stevens Inst. of Tech., Hoboken, NJ. Dept. of Civil, Environmental and Coastal Engineering.
For primary bibliographic entry see Field 2F.
W91-03860

2E. Streamflow and Runoff

TRAVELTIME AND REAERATION COEFFICIENTS FOR THE NORTH PLATTE RIVER, CASPER TO ORIN, WYOMING.
Geological Survey, Cheyenne, WY. Water Resources Div.
J. G. Rankl, and M. A. Carnevale.
Available from WY Dept. Environmental Quality; Herschler Bldg., Cheyenne, WY 82002. Wyoming Department of Environmental Quality, Cheyenne, State Cooperative Report, 1989. 34p, 11 fig, 6 tab, 24 ref. Project no. WY090.

Descriptors: *Dye dispersion, *Flow velocity, *North Platte River, *Path of pollutants, *Reaeration, *Streamflow data, *Tracers, *Traveltime, *Wyoming, Dye concentrations, Flow duration, Flow rates.

The opportunities for accidental spills of hazardous wastes into the North Platte River between Casper and Orin, Wyoming, are numerous. Highways, railroads, and pipelines cross and parallel the North Platte River. Treated wastewater from cities, industries, and refineries is discharged to the river. The report describes the movement in water of materials that may be spilled or discharged into the North Platte River. Traveltime and dispersion measurements were made on the North Platte River between Casper and Orin at discharges of 800, 890, and 3,100 cu ft/sec. The rate of movement of soluble material spilled or discharged into the North Platte River can be estimated from graphs developed from the four traveltime measurements. The following traveltime characteristics were developed: traveltime of the center of the tracer cloud as a function of stream discharge, velocity of the leading edge and peak concentration of the tracer cloud in relation to stream discharge, tracer-cloud passage time in relation to distance, and unit-peak concentration as a function of traveltime. On the basis of gas-tracer and dye-tracer data for a stream discharge of 800 cu ft/sec, reaeration coefficients were measured for three reaches of the North Platte River. Measured reaeration coefficients ranged from 4.85 to 6.70/day at 20 C, in base-e logarithm units. Reaeration coefficients computed from empirical equations were compared to reaeration coefficient measured in this study. (USGS)
W91-02959

BASIN CHARACTERISTICS, HISTORY OF STREAM GAGING, AND STATISTICAL SUMMARY OF SELECTED STREAMFLOW RECORDS FOR THE RAPID CREEK BASIN, WESTERN SOUTH DAKOTA.
Geological Survey, Rapid City, SD. Water Resources Div.
D. G. Driscoll, and J. S. Zogorski.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-120, 1990. 147p, 29 fig, 75 tab, 22 ref.

Descriptors: *Rapid Creek Basin, *South Dakota, *Stream gaging, *Surface water data, *Surface-groundwater relations, Basin characteristics.

The report presents a summary of basin characteristics affecting streamflow, a history of the U.S. Geological Survey's stream-gaging program, and a compilation of discharge records and statistical summaries for selected sites within the Rapid Creek basin. It is the first in a series which will investigate surface-water/groundwater relations along Rapid Creek. The summary of basin characteristics includes descriptions of the geology and hydrogeology, physiography and climate, land use and vegetation, reservoirs, and water use within the basin. A recounting of the U.S. Geological Survey's stream-gaging program and a tabulation of historic stream-gaging stations within the basin are furnished. A compilation of monthly and annual mean discharge values for nine currently operated, long-term, continuous-record, streamflow-gaging stations on Rapid Creek is presented. The statistical summary for each site includes summary statistics on monthly and annual mean values,

correlation matrix for monthly values, serial correlation for 1 year lag for monthly values, percentile rankings for monthly and annual mean values, low and high value tables, duration curves, and peak-discharge tables. Records of monthend contents for two reservoirs within the basin also are presented. (USGS)
W91-02968

TIME OF TRAVEL OF SOLUTES IN THE TRINITY RIVER FROM DALLAS TO TRINIDAD, TEXAS, MAY AND AUGUST 1987.
Geological Survey, Austin, TX. Water Resources Div.
W. S. Gain.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-614, 1990. 1 sheet, 3 fig, 1 tab, 4 ref.

Descriptors: *Dye releases, *Solute transport, *Texas, *Tracers, *Traveltime, *Trinity River, Dye tracing, Fluorometry, Path of pollutants, Solutes.

A study of the time-of-travel of solutes in a reach of the Trinity River from Dallas to Trinidad, Texas, was conducted in May and August 1987 using 20% Rhodamine WT dye and fluorometry. Two injections of dye were made--one in each of two subreaches--and tracked at several locations downstream. Discharges on the river ranged from 700 to 1,160 cu ft/sec. Traveltime data are presented with a map of the study reach, dye-concentration plots, and traveltime versus distance plots. The mean velocity of the concentration peak for the upper subreach was 1.18 ft/sec. The mean peak velocity for the lower subreach was 1.02 ft/sec. (USGS)
W91-02969

TECHNIQUES FOR ESTIMATING FLOOD-PEAK DISCHARGES OF RURAL, UNREGULATED STREAMS IN OHIO.
Geological Survey, Columbus, OH. Water Resources Div.
G. Koltun, and J. W. Roberts.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4126, 1990. 68p, 3 fig, 23 ref.

Descriptors: *Flood peak, *Ohio, *Rainfall-runoff relationships, *Rural areas, Estimating equations, Log-Pearson analysis, Statistical methods.

Multiple-regression equations are presented for estimating flood-peak discharges having recurrence intervals of 2, 5, 10, 25, 50, and 100 years at ungaged sites on rural, unregulated streams in Ohio. The average standard errors of prediction for the equations range from 33.4% to 41.4%. Peak discharge estimates determined by log-Pearson Type III analysis using data collected through the 1987 water year are reported for 275 streamflow-gaging stations. Ordinary least-squares multiple-regression techniques were used to divide the State into three regions and to identify a set of basin characteristics that help explain station-to-station variation in the log-Pearson estimates. Contributing drainage area, main-channel slope, and storage area were identified as suitable explanatory variables. Generalized least-square procedures, which include historical flow data and account for differences in the variance of flows at different gaging stations, spatial correlation among gaging station records, and variable lengths of station record were used to estimate the regression parameters. Weighted peak-discharge estimates computed as a function of the log-Pearson Type III and regression estimates are reported for each station. A method is provided to adjust regression estimates for ungaged sites by use of weighted and regression estimates for a gaged site located on the same stream. Limitations and shortcomings cited in an earlier report on the magnitude and frequency of floods in Ohio are addressed in this study. Geographic bias is no longer evident for the Maumee River basin of northwestern Ohio. No bias is found to be associated with the forested-area characteristic for the range used in the regression analysis (0.0 to 99.0%), nor is this characteristic significant in explaining peak discharges. Surface-mined area likewise is not significant in explaining peak discharges, and the regression equations are not biased when applied to basins having approximately 30% or less surface-mined area. Analyses of residuals indicate that the equations tend to overestimate flood-peak discharges for basins having approximately 30% or more surface-mined area. (USGS)
W91-02972

EVALUATION OF GROUND-WATER RECHARGE ALONG THE GILA RIVER AS A RESULT OF THE FLOOD OF OCTOBER 1983, IN AND NEAR THE GILA RIVER INDIAN RESERVATION, MARICOPA AND PINAL COUNTIES, ARIZONA.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-02977

FLOOD OF DECEMBER 1987 IN CENTRAL AND EASTERN ARKANSAS.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 4A.
W91-02978

WATER RESOURCES OF THE ELK RIVER BASIN, WEST VIRGINIA.
West Virginia Dept. of Natural Resources, Charleston. Div. of Water Resources.
M. V. Mathes, and S. M. Ward.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. West Virginia Dept of Natural Resources, Division of Water Resources, River Basin Bulletin 6, 1990. 37p, 17 fig, 37 ref.

Descriptors: *Hydrogeology, *Water resources data, *West Virginia, Elk River basin, Groundwater, Groundwater quality, Land use, Streamflow, Water quality, Well yield.

The Elk River basin is located in central West Virginia and drains 1,533 sq mi. The water resources of the Elk River basin are used by 12% of the population of West Virginia. In 1984, more than 9 billion gallons of water were withdrawn from the basin. The mean annual outflow of the Elk River is about 2,300 cu ft/sec, which is equivalent to 21 in of runoff. Streamflow in the lower reaches of the Elk River is regulated by Sutton Reservoir, which decreases the magnitude of flood peaks and augments low flow. Surface water in the Elk River and its major tributaries is poorly buffered and susceptible to acidification. Concentrations of dissolved iron, chloride, and manganese exceeded State water quality standards at some sites. Groundwater quality varies with respect to topography and hydrogeologic unit. Wells on hilltops yielded water with greater hardness, lower pH, lower iron concentrations, and higher hardness and sulfate concentrations than did wells in valleys. Water from the Pottsville Group in aquifers in the Lower Pennsylvanian rocks was softer, more acidic, and had a higher concentration of dissolved iron and manganese than water from other hydrogeologic units. Water from the Conemaugh Group in aquifers in the Upper Pennsylvanian rocks was the most mineralized. Reported well yields ranged from 0.08 to 1,000 gallons/min and were greater for wells in valleys than wells on hillsides or hilltops. (USGS)
W91-02982

METHOD FOR COMPUTING SHEETFLOW RUNOFF FOR FLAT SLOPES.
South Florida Water Management District, West Palm Beach. Dept. of Resource Management.
For primary bibliographic entry see Field 7B.
W91-03065

SIMULATION OF WETLAND FLOW DYNAMICS.
South Florida Water Management District, West Palm Beach. Dept. of Resource Management.
For primary bibliographic entry see Field 2H.
W91-03066

PARTIAL AREA CONCEPT AND ITS APPLICATION TO THE PROBLEM OF SEDIMENT SOURCE AREAS.
Alberta Univ., Edmonton. Dept. of Geography.
I. A. Campbell.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 128-138, 70 ref.

Descriptors: *North Carolina, *Partial area runoff, *Rainfall-runoff relationships, *Sediment sources, *Soil erosion, *Tennessee, Catchment basins, Comparison studies, Overland flow, Storm runoff, Water pollution sources.

It is now recognized that the partial area concept is a more broadly applicable way to view runoff generation than the Hortonian overland flow approach. However, the linkage between partial area runoff and sediment source areas has not been described widely in the literature on sediment production and yield nor has it been extensively investigated in the field. Runoff and sediment yield patterns and processes have been treated largely as separate components, if not as independent processes. Application of the partial area concept to overland flow leads to the conclusion that runoff in almost all cases will be generated from an area much smaller than the total basin area. Studies in North Carolina and Tennessee showed that no more than 40% of the basin surface areas typically contributed to even heavy storm runoff and some basins, on average, contributed runoff from only 4.6% of their area. This general principle seems to hold in studies conducted on very large river basins as well, such as the Nile and Yellow River (China). Unfortunately, most published data do not reveal the relationships because the required detailed observations are not available. The implications of the partial area concept are that most methods of working with sediment source and yield data are inadequate and largely unrealistic. If small areas of basins are contributing most or nearly all of the runoff and sediment yield measured at the basin mouth, serious misconceptions will result about processes operating in the watershed if basinwide averaging techniques are used. The extension of these techniques to determine regional or global erosion rates is at best a simplistic speculative exercise. (See also W91-03117) (Rochester-PTT)
W91-03129

ESTIMATING EROSION ON PLOT, FIELD, AND WATERSHED SCALES.
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
For primary bibliographic entry see Field 2J.
W91-03131

UPLAND EROSION AND DOWNSTREAM SEDIMENT DELIVERY.
Stall (John B.) Ltd., Urbana, IL.
For primary bibliographic entry see Field 2J.
W91-03135

PRELIMINARY ANALYSIS OF RUNOFF AND SOIL LOSS FROM SELECTED LONG-TERM PLOTS IN AUSTRALIA.
Soil Conservation Service of New South Wales, Sydney (Australia).
For primary bibliographic entry see Field 2J.
W91-03155

EXPERIMENTAL DATA ON RUNOFF GENERATION.
Katholieke Univ. Leuven (Belgium). Lab. voor Experimentele Geomorfologie.
J. De Ploey.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 528-539, 4 fig, 28 ref.

Descriptors: *Belgium, *Rainfall-runoff relationships, *Roughness, *Runoff, *Soil erosion, *Soil physical properties, Overland flow, Sheet erosion, Soil surfaces, Soil types, Surface sealing.

In recent years the Laboratory for Experimental Geomorphology in Leuven, Belgium, has focused part of its research on problems dealing with runoff generation. Several runoff threshold conditions on sandy and loamy topsoils, either bare sediments or cropland, and slopes with a steppe vegetation are discussed here. Results from throughout the world are reviewed as they apply to runoff generation and topsoil conditions; roughness elements, stemflow, and runoff generation; and the time to runoff (Tr). Progress in understanding of runoff generation will depend largely on improvement of current techniques and development of advanced techniques to follow changing topsoil conditions during rainfall. Particular attention must be paid to the ambivalent effects of several factors (e.g., roughness elements that control runoff events). Laboratory experiments will be fundamental for elucidating specific mechanisms of runoff generation. The factors in runoff promotion considered here would at first seem to enhance soil erosion, but they can have ambivalent impact on erodibility of topsoils, especially on slopes of low declivity. Roughness elements, if their cover density exceeds a certain critical value, also may protect against erosion. Sealing and crusting, by increasing topsoil smoothness, reduce the resistance to runoff flow. They therefore may reduce topsoil erodibility. This effect is limited to sheetwash, but it helps explain why erosion rates decrease with time on smooth interrill areas under constant flow conditions. (See also W91-03117) (Rochester-PTT)
W91-03160

RIVER MEANDERING.
Water Resources Monograph 12. American Geophysical Union, Washington. 1989. 485p. Edited by Syunsuke Ikeda, and Gary Parker.

Descriptors: *Channel flow, *Channel morphology, *Geomorphology, *Meanders, *River beds, *River flow, *Sediment transport, Mathematical models, Model studies, Shear stress, Theoretical analysis, Topography.

This monograph is an overview of research undertaken by five Japanese and five Americans of various backgrounds (geology, engineering, and geography) on the subject of river meandering. The core group of participants attended three workshops which included tours of rivers and research facilities in the United States and Japan. The fourteen papers compiled in the monograph deal with the following subjects: boundary shear stress and sediment transport in river meanders of sand and gravel; sedimentary controls on channel migration and origin of points bars in sand-bedded meandering rivers; flow in meandering channels with natural topography; sediment transport and sorting at bends; sediment control by submerged vanes; analysis of 2-dimensional bed topography model for rivers; linear theory of river meanders; studies on qualitative and quantitative prediction of meander channel shift, finite amplitude development of alternate bars; alternate bars and meandering (free, forced and mixed interactions); evolution and stability of erodible channel beds; observations on several recent theories of resonance and overdeepening in meandering channels; bar and channel formation in braided streams; and topographic response of a bar to variation in discharge. (See W91-03204 thru W91-03217) (Geiger-PTT)
W91-03203

BOUNDARY SHEAR STRESS AND SEDIMENT TRANSPORT IN RIVER MEANDERS OF SAND AND GRAVEL.
California Univ., Berkeley. Dept. of Geology and Geophysics.
W. E. Dietrich, and P. Whiting.
IN: River Meandering. Water Resources Monograph 12. American Geophysical Union, Washington. 1989. p 1-50, 29 fig, 1 tab, 45 ref. NSF Grants ENG78-16977 and CEE-8307142. American Chemical Society Grant ACS-PRF-18427-AC2.

Descriptors: *Channel morphology, *Geomorphology, *Meanders, *River flow, *Sediment transport, *Shear stress, Bed load, Channel flow, Channel scour, Gravel, Mathematical studies, Particle size, Sand, Topography.

Field measurements in a sand-bedded river and in two gravel-bedded ones were compared to examine controls on boundary shear stress fields, sediment transport processes, and sorting in meanders. Analysis of detailed flow field measurements in the sand-bedded river meander and over a gravel-bedded alternate bar reveals a well-defined spatial structure to the magnitude and sign of forces controlling boundary shear stress that arise from topographically-induced spatial accelerations. The relationship between bedload transport and boundary shear stress fields in river meanders varies with size and heterogeneity of bed material. In bends of moderately to well sorted sand in flows generating boundary shear stresses well above critical (such as in large sandy rivers), downstream varying boundary shear stress is matched by topographically-induced cross-stream transport of sediment. In meanders with high excess shear stress but poorly sorted coarse sand and fine gravel, boundary shear stress variation downstream is partially matched by surface grain size adjustments and by net cross-stream sediment flux. Maxima of bedload transport rate and boundary shear stress do not correspond in some areas. In gravel-bedded meanders with low excess boundary shear stress and low sediment supply, bedload may be much finer than the bed surface, and significant areas of bar surface are covered with grain sizes that constitute a very small portion of the bedload. Substantial bedload transport may only occur over a narrow portion of the bed width where boundary shear stress relative to critical stress of the surface is highest and where the sediment flux from upstream is locally concentrated. In this case, grain size adjustments dominate over topographically-induced cross-stream sediment transport in controlling the relationship between boundary shear stress and bedload transport fields. (See also W91-03203) (Author's abstract)
W91-03204

SEDIMENTARY CONTROLS ON CHANNEL MIGRATION AND ORIGIN OF POINT BARS IN SAND-BEDDED MEANDERING RIVERS.
Tsukuba Univ. (Japan). Environmental Research Center.
H. Ikeda.
IN: River Meandering. Water Resources Monograph 12. American Geophysical Union, Washington. 1989. p 51-68, 18 fig, 44 ref.

Descriptors: *Alluvial plains, *Channel morphology, *Geomorphology, *Meanders, *Sediment transport, Channel flow, Gravel, River beds, Sand.

Field observations in alluvial meandering rivers have revealed that plan form and migration pattern of channels are strongly influenced by the distribution of thick fine-grained cohesive deposits in flood plains. Meandering channels can be classified into four types according to the influence of these cohesive deposits: (1) fixed meanders, (2) restricted meanders, (3) confined free meanders, and (4) truly free meanders. Laboratory experiments and field observations of point bars in low gradient sand-bedded meandering rivers have revealed that, unlike in gravel-bedded rivers, point bars develop in response to the pattern of flow through the beds, that is point bars in these rivers are a result rather than a cause of meandering. Point bar platforms, which are the flat tops of point bars, are gradually covered in these rivers by inner bank accretions deposited out of suspension. Therefore, bends with well developed point bar platforms lacking accretion deposits must be in a state of active channel migration and, consequently widening. (See also W91-03203) (Author's abstract)
W91-03205

FLOW IN MEANDERING CHANNELS WITH NATURAL TOPOGRAPHY.
Washington Univ., Seattle. Geophysics Program.
J. M. Nelson, and J. D. Smith.
IN: River Meandering. Water Resources Monograph 12. American Geophysical Union, Washington. 1989. p 69-102, 13 fig, 24 ref.

Descriptors: *Channel flow, *Channel morphology, *Geomorphology, *Meanders, *Model studies, *Topography, Flow velocity, Sediment transport, Shear stress.

A predictive model for velocity, surface elevation, and boundary shear stress fields in natural meander bends is presented. The approach retains streamwise convective accelerations in the lowest order momentum equations and can be used to investigate flow in channel bends with curvature and topography that vary significantly in the streamwise direction, as is the case in most natural streams and rivers. The total boundary shear stress field obtained from computations includes both skin friction and the form drag associated with pressure forces on bars and bedforms. A simple method for removing the form drag component permits computation of the bottom stress responsible for sediment transport. Results of calculations are compared to measurements obtained in Muddy Creek, a sand-bedded meandering stream in Wyoming possessing the characteristics typical of natural channels. Model predictions of velocity, boundary shear stress, and surface elevation were in excellent agreement with the measurements, primarily due to the careful treatment of convective accelerations in the governing equations. (See also W91-03203) (Author's abstract)
W91-03206

ANALYSIS OF A 2-D BED TOPOGRAPHY MODEL FOR RIVERS.
Waterloopkundig Lab. te Delft (Netherlands).
N. Struiksma, and A. Crosato.
IN: River Meandering. Water Resources Monograph 12. American Geophysical Union, Washington. 1989. p 153-180, 12 fig, 6 tab, 32 ref.

Descriptors: *Channel morphology, *Geomorphology, *Mathematical models, *Meanders, *Model studies, *River beds, *Sediment transport, *Topography, Comparison studies, Flow velocity, Steady flow, Unsteady flow.

Processes of river bed deformation were studied by analysis of a time-dependent 2-dimensional model for river bed topography. The occurrence and behavior of propagating alternate bars are described with a non-steady state analysis. Due to the relatively large propagation velocity of these bars, this type of bed perturbation cannot give an explanation of the much more steady meandering process, which is characterized by the point bar-pool configuration. A steady state analysis turns out to be more appropriate to describe the meandering process. In terms of wave length and longitudinal damping rate, this analysis provides a good description of the phenomena involved. For conditions prevailing in meandering rivers it appears that the result of the interaction between water and sediment motion depends on the ratio of two characteristic adaptation lengths which govern the two independent equations for the flow and for the bed deformation, respectively. In addition, it is shown that the degree of non-linearity of the sediment transport with flow velocity is also an important parameter. The results of the analysis are compared with data from a straight flume experiment with movable bed, in which at the inflow a steady perturbation was imposed, and with data from a curved flume experiment with movable bed and fixed banks. The predicted equilibrium bed topographies in the two experiments agree well with the measured ones. In the straight flume experiment the complete and the simple versions of the linear model give rather similar results (the simple model in this case gives a better prediction). The unsteady linear solution of the complete model gives a rather good prediction of alternate bar wave lengths. The influence of curvature and of secondary flow inertia are shown to play an important role in the phenomenon. In this case the complete model cannot be further simplified. (See also W91-03203) (Geiger-PTT)
W91-03209

LINEAR THEORY OF RIVER MEANDERS.

Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 2J.
W91-03210

STUDIES ON QUALITATIVE AND QUANTITATIVE PREDICTION OF MEANDER CHANNEL SHIFT.
Hokkaido Univ., Sapporo (Japan). Dept. of Civil Engineering.
K. Hasegawa.
IN: River Meandering. Water Resources Monograph 12. American Geophysical Union, Washington. 1989. p 215-235, 12 fig, 34 ref.

Descriptors: *Bank erosion, *Channel flow, *Channel morphology, *Geomorphology, *Mathematical models, *Meanders, *Model studies, Literature review, Qualitative analysis, Quantitative analysis.

Studies on alluvial meandering rivers in Japan show that alternative bars appear to be a universal feature of these rivers, two meander patterns are found in the river, and in sinuous meanders, the whole bend migrates downstream at a uniform rate. Meander patterns are classified as simple symmetrical, simple asymmetrical, compound symmetrical, compound asymmetrical, and lobing or double heading. Migration rates of natural river channels have been measured by regression relations between a meander loop and the upstream drainage area, and by dendrochronology. A mechanistic analysis for meander channel changes is based on a theory that assumes the bank erosion rate at any point is in proportion to the near-bank perturbation of depth-averaged flow velocity. Studies of the interrelationships among factors governing channel changes in alluvial rivers show that the influence of channel planform on bank shift is indirect. The planform gives rise to bank erosion or accretion by means of the associated variation in bed topography. However, channel planform does play an important local role in the formation of planimetric flow separation along the inside bank. When this occurs it can yield strong deposition of suspended sediment. This phenomenon can be viewed as a direct effect of channel planform on bank shift. Studies using the universal erosion coefficient in equations governing bank erosion show that the general bank erosion coefficient and the general coefficient for the real erosion rate during a flood maintain values of a similar order of magnitude among a variety of rivers. These parameters thus provide a universal means for characterizing the coefficient necessary to predict bank erosion rates. (See also W91-03203) (Geiger-PTT)
W91-03211

FINITE AMPLITUDE DEVELOPMENT OF ALTERNATE BARS.
Public Works Research Inst., Tsukuba (Japan). River Hydraulics Div.
S. Fukuoka.
IN: River Meandering. Water Resources Monograph 12. American Geophysical Union, Washington. 1989. p 237-265, 21 fig, 23 ref.

Descriptors: *Channel flow, *Channel morphology, *Geomorphology, *Mathematical models, *Meanders, Bank erosion, Reviews, River beds, Sediment discharge.

The planform of the channel associated with the concentration of flow along the river bank is the meander; the corresponding bedform is the alternate bar. To carry out safe and proper flood control measures, it is necessary to determine the equilibrium shapes of alternate bars and meanders, as well as the flow in channels with such morphological features. The flow in a channel with arbitrary periodic planform and alternate bar pattern can be determined with considerable accuracy by using plane two-dimensional analysis. Flow over alternate bars has been studied taking into account the nonlinearity of the flow. The nonlinearity of flow plays an important part in stabilizing the wave height of alternate bars. Since the analysis becomes complicated when the nonlinearity of flow is considered, a straight channel is assumed for the planform to simplify the representation of the shape of alternate bars. The hydraulic indicators for bank erosion to be used in a straight channel with alternate bars and erodible banks were investigated. The transverse slope of the bed, streamline deviation, water level and flow velocity are appropriate hydraulic indicators of a point of flow attack. Temporally varying bars were investigated by photographing and analyzing the movement of bed material with a video camera. The process of development leading to the equilibrium of alternate bars was explained from the relationship between the flow velocity vector and the sediment discharge distribution. The spatial distribution of longitudinal and transverse bed load transport rates and the process of sediment transport and the path difference according to grain size were measured in a bend of a small meandering river with an equilibrium bed profile. An equilibrium bed profile appears when a net outward sediment discharge occurs in a region with maximal bed shear stress. Dimensional analysis is often used to predict equilibrium wave height and length. The equilibrium wave height of alternate bars was studied in the context of changes in sediment discharge. (See also W91-03203) (Geiger-PTT)
W91-03212

ALTERNATE BARS AND MEANDERING: FREE, FORCED AND MIXED INTERACTIONS.
Genoa Univ. (Italy). Inst. of Hydraulics.
G. Seminara, and M. Tubino.
IN: River Meandering. Water Resources Monograph 12. American Geophysical Union, Washington. 1989. p 267-320, 19 fig, 64 ref.

Descriptors: *Channel flow, *Channel morphology, *Geomorphology, *Mathematical models, *Meanders, *Sediment transport, Bank erosion, Boundary conditions, Resonance, Sediment erosion, Steady flow, Unsteady flow.

A systematic treatment is given of the linear and weakly nonlinear aspects of the development of flow and bottom perturbations of lengthscale of the order of channel width in developing meanders. Mathematical models show that an originally straight channel with cohesionless boundary and uniform grain size, unless the channel is too narrow or too wide, undergoes an instability process which, on a relatively fast time scale, leads to the formation of migrating perturbations (alternate bars). As channel widening proceeds, provided the width ratio exceeds a second threshold value above which spatial disturbances may grow, the channel undergoes a second instability process, a planimetric one. The latter process, the details of which still require to be elucidated, is not primarily determined but is definitely affected by the presence of free bars. As the amplitude of meander increases, so does sinuosity, so that free bars tend to decrease their amplitude till they disappear, leaving only forced bars to induce bank erosion. The above model needs further refinements to be able to describe features of the process which have so far been neglected, namely transport in suspension, grain sorting, entrance and wall effects, and unsteadiness. The effect of resonance is the same in all the mathematical models presented. Further experimental and field verification of the whole picture is also needed through carefully designed experiments. (See also W91-03203) (Geiger-PTT)
W91-03213

EVOLUTION AND STABILITY OF ERODIBLE CHANNEL BEDS.
Washington Univ., Seattle. Geophysics Program.
J. M. Nelson, and J. D. Smith.
IN: River Meandering. Water Resources Monograph 12. American Geophysical Union, Washington. 1989. p 321-377, 37 ref.

Descriptors: *Channel erosion, *Channel morphology, *Geomorphology, *Mathematical models, *Meanders, *Model studies, *Sediment erosion, Algorithms, Channel stability, Sediment transport, Shear stress, Topography.

A computational model for flow and boundary shear stress fields in natural channels is combined with a bedload transport algorithm to investigate the genesis and finite amplitude characteristics of riverine bars. Since the time scales associated with bar growth and migration are typically much larger than the time scales of the flow, the flow is treated in a quasi-steady manner, and the modification of the bed topography due to convergences and divergences in the sediment flux field is coupled to the flow model using a simple iterative technique. The topographic evolution algorithm yields accurate predictions of the development of point bars in curved channels and indicates that, while the origin of point bars is primarily due to curvature-induced secondary flow, the ultimate stability of these features is related to topographically-induced streamwise convective accelerations, as well as to gravitational modification of sediment fluxes by bar slopes. The technique presented is also used to investigate the mechanics of alternate bars in straight channels. Comparison of the nonlinear theory with a simple linear stability analysis for these features is used to demonstrate the importance of the nonlinear effects, and to provide a clearer physical understanding of the alternate bar instability. In contrast to point bars, the initial instability of alternate bars is shown to depend on a simple topographic steering response, while the finite amplitude characteristics of these features depend on gravitational effects and the production of secondary flow associated with the curvature of flow streamlines. The evolution model yields good predictions of the finite amplitude morphology of both point and alternate bars, as demonstrated by comparison of model predictions and measured bathymetry for several experimental studies. (See also W91-03203) (Author's abstract)
W91-03214

OBSERVATIONS ON SEVERAL RECENT THEORIES OF RESONANCE AND OVERDEEPENING IN MEANDERING CHANNELS.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
G. Parker, and H. Johannesson.
IN: River Meandering. Water Resources Monograph 12. American Geophysical Union, Washington. 1989. p 379-415, 7 fig, 1 tab, 42 ref, append.
NSF Grants MSM-8311721 and INT-8412678.

Descriptors: *Channel flow, *Channel morphology, *Geomorphology, *Mathematical models, *Meanders, *Model studies, *Resonance, Comparison studies, Sinuous flow, Theoretical analysis.

Three recent linear treatments of alternate bars and flow in meandering channels are compared in terms of a unified framework that is used to clarify the relation between such self-excited topographic effects as alternate bars and curvature-driven phenomena such as point bars. The equation of depth-averaged transverse momentum balance, which may be driven by topography or curvature, is decoupled from the equation governing secondary flow, which is driven essentially by curvature alone. All three theories are found to yield similar results for the phenomena of resonance and overdeepening. For typical natural channels, the equation of transverse momentum balance can be decomposed into a relation governing depth-averaged transverse velocity, and a relation governing helical secondary flow. The two are not directly coupled to each other. Helical secondary flow may be taken to be purely curvature-driven, and unaffected by bed topography at the linear level, whereas the depth-averaged component may be strongly affected by bed topography. Secondary flow may be neglected in a linear treatment of alternate bars. Alternate bar instability can be predicted even in a theory that neglects the linear inertial and frictional terms associated with depth-averaged transverse velocity. The approximate theory provides critical values of ratio of half-width to base flow depth for the inception of alternate bars that are in essential agreement with the more previous theories. The same approximation, i.e. neglect of ratio half-width to base flow depth terms associated with depth-averaged transverse velocity, yields a linear treatment of bend flow that is much simpler from that of (See also W91-03203) (Author's abstract)
W91-03215

BAR AND CHANNEL FORMATION IN BRAIDED STREAMS.
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
Y. Fujita.
IN: River Meandering. Water Resources Monograph 12. American Geophysical Union, Washington. 1989. p 417-462, 30 fig, 3 tab, 75 ref.

Descriptors: *Braided streams, *Channel flow, *Channel morphology, *Geomorphology, *Meanders, *Sediment transport, Hydraulic properties, Theoretical analysis.

Detailed hydraulic experiments were carried out on the behavior of multiple row bars and the formation of braided streams in three flumes, with widths of 0.5, 1.8, and 3.0 m. The characteristic features of change in bed configuration, and also stream bed variation, were described. Higher modes of bars were observed to evolve into lower ones. Braided patterns appeared in cases with small depths; during this transition to lower modes, bar geometry changed suddenly, increasing in wavelength and heights. Bars in high modes proved to have the same hydraulic properties as alternate bars. Several results of previous studies on alternate bars could be applied to predict the behavior of multiple-model bars. It was concluded that the formation of bars of various modes, and stream braiding, as well, can be predicted by a criterion that allows the co-existence of several modes, and corresponds to results of an existing linear stability theory. The times required for the development and the reduction of bar mode are analyzed using the bar heights of individual modes in equilibrium. Mechanisms controlling the formation of the lowest mode and the development of braided streams should be examined more quantitatively from the viewpoint of sediment transport. (See also W91-03203) (Author's abstract)
W91-03216

TOPOGRAPHIC RESPONSE OF A BAR IN THE GREEN RIVER, UTAH TO VARIATION IN DISCHARGE.
For primary bibliographic entry see Field 2J.
W91-03217

SPECIAL FLOOD HAZARD EVALUATION REPORT: CANASERAGA CREEK, TOWN OF GROVE, ALLEGANY COUNTY, NEW YORK.
Army Engineer District, Buffalo, NY.
For primary bibliographic entry see Field 6F.
W91-03225

RESTORATION OF DEGRADED RIVERINE/RIPARIAN HABITAT IN THE GREAT BASIN AND SNAKE RIVER REGIONS.
White Horse Associates, Smithfield, UT.
S. E. Jensen, and W. S. Platts.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 367-404, 14 fig, 94 ref, 2 append.

Descriptors: *Habitat restoration, *Riparian land, *Stream restoration, *Water resources management, *Wetland restoration, *Wetlands, Environmental impact, Planting management, Riparian waters, Soil-water-plant relationships, Water resources development, Watershed management, Wildlife habitats.

Riverine/riparian habitat (RRH) includes interdependent aquatic (riverine) and streamside (riparian) resources that are valuable for fish and wildlife habitat, flood storage and desynchronization, nutrient cycling and water quality, recreation, and heritage values. RRH includes resources both wetter and drier than stipulated for wetlands. Whereas the 'natural or achievable state' of a riparian habitat may be wetland, the 'existing state' may be non-wetland because of natural or anthropogenically-induced changes in the hydrologic character of RRH. There are many different types of RRH, each with distinctive structure, function, and values. Restoration commonly requires: planning to identify preliminary goals and a general approach; baseline assessments and inventories; designs from which the feasibility of accomplishing goals can be assessed; evaluation to assure compliance with designs; and monitoring of variables important to goals and objectives. The goals, approach, and design of restoration projects must be tailored to each type of RRH. Some general elements important to restoration of degraded RRH are: establishment of hydrologic conditions compatible with project goals; efficient handling of soil and substrates in construction; selection and propagation of plants suited to the site and project goals; evaluation of features to enhance habitat for target species; maintenance and control of impacts; and scheduling construction to reflect site constraints and goals. (See also W91-03244) (Author's abstract)
W91-03259

VARIANCES AND COVARIANCES OF THE MAXIMUM ENTROPY ESTIMATORS FOR THE PEARSON TYPE-3 DISTRIBUTION.
Asian Inst. of Tech., Bangkok (Thailand).
For primary bibliographic entry see Field 7C.
W91-03308

KNOWLEDGE-BASED EXPERT SYSTEM FOR FLOOD FREQUENCY ANALYSIS.
Queen's Univ., Kingston (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W91-03309

HEAT AND MASS BALANCE OF AN ABLATING ICE JAM.
National Hydrology Research Inst., Saskatoon (Saskatchewan). Northern Hydrology Section.
For primary bibliographic entry see Field 2C.
W91-03310

EFFECT OF DRAINAGE CHANNEL ON EVOLUTION OF WATER TABLE DUE TO RECHARGE FROM TWO PARALLEL CANALS.
Irrigation Design Organization, Roorkee (India).
For primary bibliographic entry see Field 2F.
W91-03358

PHYTOPLANKTONIC BIOMASS AND PRODUCTIVITY IN THE RHONE RIVER PLUME IN SPRING TIME (BIOMASSE ET PRODUCTION PHYTOPLANCTONIQUES DANS LE FRONT DU PANACHE RHODANIEN: SITUATION PRINTANIERE).
Jaffna Univ. (Sri Lanka). Dept. of Geography.
C. Videau, and M. Leveau.
Comptes Rendus de l'Academie des Sciences (Serie 3) Sciences de la Vie CRAMED, Vol. 311, No. 6, p 219-224, September 13, 1990. 3 fig, 1 tab, 10 ref. English summary.

Descriptors: *Chlorophyll, *Estuarine environment, *Phytoplankton, *Plumes, *Primary productivity, *Rhone River, Biomass, Carbon, Estuaries, Stratification.

The distribution of chlorophyll biomass and productivity in the Rhone River plume was studied in three size-fractionated phytoplankton assemblages: microplankton (>10 microns), nanoplankton (10-3 microns) and picoplankton (<3 microns) in relation to hydrological structures. Measurements were made at different stations inside and outside the Rhone plume in May 1988. Seawater samples from 4 light levels were fractionated by passing through a cascade of three different membranes for chlorophyll and carbon fixation measurements (4 hr in situ simulated incubation). Inside the plume, chlorophyll biomass of entire populations showed typical profiles of stratified waters with a chlorophyll maximum in a range from 5 to 8 micrograms/L located at the maximum density gradient. Outside the discharge, surface water layers were more homogenous and chlorophyll values did not exceed 3 micrograms/L. Water layer density influenced the distribution and the biological activity of phytoplankton size fractions. In the upper layer characterized by low salinity, half the chlorophyll biomass was due to nanoplankton. Nanoplankton and picoplankton fixed inorganic carbon to a similar extent (40%). In underlying typical marine waters, 60% of phytoplankton biomass and productivity were achieved by picoplankton. Transitional waters were characterized by an abundant microplankton constituting more than 50% of total chlorophyll biomass whose carbon fixation was higher at the pycnocline and, particularly, near the plume front. (Geiger-PTT)
W91-03392

FLOW DISTRIBUTION IN THE ST. LAWRENCE RIVER SYSTEM AT WOLFE ISLAND, KINGSTON BASIN, LAKE ONTARIO.
McMaster Univ., Hamilton (Ontario). Dept. of Civil Engineering and Engineering Mechanics.
I. K. Tsanis, and C. R. Murthy.
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 3, p 352-365, 1990. 8 fig, 5 tab, 11 ref.

Descriptors: *Flow discharge, *Lake Ontario, *Limnology, *St Lawrence River, Flow measurement, Flow rates, Flowmeters, Hydrologic data collections, Satellite technology.

Determination of the mass output through the St. Lawrence River outflow system is an important component in computing a mass balance of chemical loadings in Lake Ontario. Toward this goal, a network of self recording current meter moorings were deployed in the main channels of the St. Lawrence River system in Lake Ontario during 1986 and 1987. On two occasions in 1987, detailed Lagrangian experiments were carried out using a cluster of satellite drifters. The time series data from the current meter network and Lagrangian drifter experiments provided the horizontal and vertical distribution of currents that are adequate to compute the distribution of water transport through the St. Lawrence outflow. The flow distribution in the St. Lawrence River at Wolfe Island is approximately 55% in the south channel and 45% in the north channel. The total flow rate through the St. Lawrence River system from the present study is in good agreement with the direct measurements at the powerplant control facilities at Cornwall. (Author's abstract)
W91-03401

COMPARISON OF MEASURED AND SIMULATED FLOWS DURING THE 15 DECEMBER 1987 DETROIT RIVER FLOW REVERSAL.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
J. A. Derecki, and F. H. Quinn.
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 3, p 426-435, 1990. 10 fig, 6 ref.

Descriptors: *Detroit River, *Flow models, *Flow profiles, *Great Lakes, *Model studies, *Path of pollutants, *River flow, *Wind-driven currents, Flow measurement, Flow velocity, Mathematical models, Simulation analysis, Water level fluctuations.

Flow reversals in the Detroit River were directly measured by an acoustic Doppler current profiler deployed on the river bottom at Ft. Wayne for about 8 hr on 15 December 1987. The meter provided continuous measurements of the vertical velocity distribution for approximately 1-m depth segments in the overhead water column at quarter-hour intervals. These measurements provided an ideal data set to analyze river dynamics associated with flow reversals and to evaluate the importance of major factors necessary for the occurrence of flow reversals in the river. Analysis of the measurements showed that reasonably accurate simulation of flow reversals with the unsteady flow models require the inclusion of surface wind shear and the use of small time increments that are much shorter than the standard hourly water level data. Model simulation with specially obtained 5 and 15 minute water level and wind data produced generally similar model flows that are reasonably close to the measured values. Because short-period (15 minute or less) wind and water level data are not readily available, river flow reversals simulated using hourly data may be significantly underestimated. (Author's abstract)
W91-03406

HABITAT DIVERSITY AND FISH REPRODUCTIVE FUNCTION OF FLOODPLAIN ECOSYSTEMS.
Lyon-1 Univ., Villeurbanne (France). Lab. d'Ecologie des Eaux Douces.
For primary bibliographic entry see Field 2H.
W91-03482

ALLOCHTHONOUS INPUT AND RETENTION IN A SMALL MOUNTAIN STREAM, SOUTH AFRICA.
Cape Town Univ. (South Africa). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W91-03488

FACTORS INFLUENCING FISH DISTRIBUTION AND COMMUNITY STRUCTURE IN A SMALL COASTAL RIVER IN SOUTHWESTERN COSTA RICA.
Wisconsin Univ.-Madison. Center for Limnology.
For primary bibliographic entry see Field 2H.
W91-03492

DYNAMIC ASPECT OF COARSE PARTICULATE ORGANIC MATTER (CPOM) ON THE SEDIMENT SURFACE OF A SECOND ORDER STREAM FREE OF DEBRIS DAMS (RITRODAT-LUNZ STUDY AREA).
Oesterreichische Akademie der Wissenschaften, Vienna. Inst. fuer Limnologie.
For primary bibliographic entry see Field 2H.
W91-03493

LITTERFALL, LEAF DECOMPOSITION AND LITTER COLONIZATION OF TESSARIA INTEGRIFOLIA (COMPOSITAE) IN THE PARANA RIVER FLOODPLAIN.
Centro de Ecologia Aplicada del Litoral, Corrientes (Argentina).
For primary bibliographic entry see Field 2H.
W91-03495

EVALUATION OF THE FISHERIES OF THE MACKINAW RIVER BASIN IN CENTRAL ILLINOIS.
Illinois Dept. of Conservation, Aledo.
For primary bibliographic entry see Field 2H.
W91-03504

USE OF PARAMETER TRANSFORMATIONS IN NONLINEAR, DISCRETE FLOOD EVENT MODELS.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
B. C. Bates.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 55-79, September 1990. 8 fig, 5 tab, 29 ref.

Descriptors: *Flood forecasting, *Hydrologic models, *Model studies, *Parameterization, *Rainfall-runoff relationships, Algorithms, Australia, Nonlinear flood event models, Parameter transformations, Statistical analysis.

The use of parameter transformations in calibration and post-calibration studies of conceptual rainfall-runoff models is often justified on the basis of their ability to speed the convergence of automatic parameter estimation algorithms, improve the sampling properties of the parameter estimates, and improve statistical inferences that are based on conventional linear model theory. An examination of the abilities of parameter transformations was undertaken using a nonlinear flood event model, rainfall-runoff data from six Australian catchments, a Gauss-Newton optimization algorithm, three measures of statistical nonlinearity, and three types of joint confidence regions (exact, likelihood, and linear theory) for the model parameters. Results indicated that the 'expected value' transformation of Ross and the power transformation of Tsai can lead to improved sampling properties and statistical inferences on model parameters. However, it is clear that the effect of model reparameterization on the convergence of optimization algorithms may only be slight, and that care must be taken when applying parameter transformations to nonlinear flood event models. (Author's abstract)
W91-03542

SHAPE PARAMETERS OF THE GEOMORPHOLOGIC UNIT HYDROGRAPH.
Electricity Generating Authority of Thailand, Nonthaburi. Meteorology and Hydrology Div.
P. Chutha, and J. C. I. Dooge.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 81-97, September 1990. 3 fig, 1 tab, 20 ref, append.

Descriptors: *Geomorphology, *Hydrograph analysis, *Model studies, *Parameter estimation, *Runoff forecasting, *Unit hydrographs, Geomorphologic unit hydrograph, Hydrography, Multireservoir networks, Numerical analysis, Regression analysis, Shape parameters, Watersheds.

Numerical experiments were carried out to explore: (1) the relationship between the dimensionless third moment and the dimensionless second moment of the classical geomorphologic unit hydrograph (GUH); (2) the sensitivity of this shape indicator to the assumption in the GUH model relating the time delay in a stream segment to some power of the segment length; (3) the relationship between the parameters of the GUH and the geomorphic parameters of the catchment. A closed form analytical solution specifying completely the GUH can be derived using only the formula for the most probable distribution of tributaries of given order among channels of higher order and the classical deterministic analysis based on routing through unequal linear reservoirs. Consequently, the parameters of the GUH can be expressed in terms of geomorphic parameters and a single scaling factor such as the delay time for the reservoir at the outlet from each first order basin or the lag of the catchment response. The dimensionless parameters of the GUH are in most cases highly determined by linear regression in logarithmic space on the geomorphic parameters, and the individual GUH parameters are sensitive to the assumption about the relative sizes of the reservoirs at the outlet of different orders but the product of the peak and the lag of GUH is remarkably stable. The shape of the GUH is closely approximated by the Nash model of a cascade of equal linear reservoirs for all three assumptions about storage variations. (MacKeen-PTT)
W91-03543

POND SEEPAGE IN TWO AND THREE DIMENSIONS.
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
G. Fipps, and R. W. Skaggs.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 133-151, September 1990. 9 figs, 5 tab, 20 ref.

Descriptors: *Hydrologic models, *Infiltration, *Model studies, *Ponds, *Seepage, *Storm runoff, *Storm water management, *Surface-groundwater relations, Hydrology, North Carolina-Barrier islands, Numerical analysis, Pond seepage, Saturated flow, Saturation zone, Seepage rates, Soil properties, Three-dimensional model, Unsaturated flow.

The State of North Carolina requires plans for stormwater, sediment, and erosion management for much of the commercial construction along the coast. Such plans may employ infiltration ponds for stormwater runoff control. Although the concept is fairly straightforward, the factors controlling the operation of these ponds are not well understood. A numerical solution to the Richards equation for three-dimensional (3-D), combined unsaturated and saturated flow was used to analyze pond seepage for geometries characteristic of the North Carolina Barrier Islands. Two-dimensional and three-dimensional seepage rates were obtained for 10 x 10 x 1 m deep ponds, located 16-195 m from the sinks, and spaced 10-190 m apart for two profile depths, 3 and 9 m. For the geometries and soil properties considered, pond seepage was dominated by flow in the saturated zone. The spacing between adjacent ponds affected seepage rates, having a greater effect for large island widths. The numerical solutions were used to develop and test an approximate analytic solution for 3-D steady pond seepage. The approximate solution was obtained by dividing the flow regime into radial and linear flow domains. The predicted rates of the analytic solution agreed with those obtained from the numerical solution. (MacKeen-PTT)
W91-03545

SATELLITE DATA TRANSMISSION AND HYDROLOGICAL FORECASTING IN THE FIGHT AGAINST ONCHOCERCIASIS IN WEST AFRICA.
Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Abidjan (Ivory Coast). Centre ORSTOM d'Adiopodoume.
For primary bibliographic entry see Field 7B.
W91-03548

HYDRAULICS OF INTERRILL OVERLAND FLOW ON A SEMI-ARID HILLSLOPE, SOUTHERN ARIZONA.
Keele Univ. (England). Dept. of Geography.
A. J. Parsons, A. D. Abrahams, and S.-H. Luk.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 255-273, September 1990. 12 fig, 2 tab, 21 ref. NATO Grant RG.85/0066.

Descriptors: *Erosion, *Hydraulic properties, *Overland flow, *Rainfall-runoff relationships, *Runoff plot, *Semiarid lands, *Soil erosion, Arizona, Flow resistance, Reynolds number, Simulated rainfall, Slopes.

Simulated rainfall experiments were conducted on an 18 by 35 m runoff plot located in southern Arizona. By using a wide plot that extended from the divide to beyond the rill heads, it was possible to examine the full range of lateral variability and downslope changes in interrill overland flow on a shrub-covered, semi-arid piedmont hillslope. The mean depth (d), mean velocity (v), and Reynolds number (Re) of overland flow were computed for two measured sections situated 12.5 and 21 m from the top of the plot. At-a-section d vs. Re and v vs. Re relations showed that increases in Re are accommodated largely by increases in d. These hydraulic relations are principally the result of resistance to flow increasing with Re as overland flow spreads into new areas. Inasmuch as the maximum (equilibrium) discharge simulated in these experiments has a return period of about 7 yr, increasing resistance to flow as Re increases may be considered typical of most overland flow events on shrub-covered, piedmont hillslopes in southern Arizona. Downslope hydraulic relations differ strikingly from at-a-section relations. Under equilibrium runoff conditions, resistance to flow decreases rapidly as Re increases, permitting increases in Re to be accommodated entirely by increases in v. The decrease in resistance to flow is due to progressive downslope concentration of flow into fewer, deeper threads. Under non-equilibrium conditions, downslope hydraulic relations may be quite different from those obtained at equilibrium, but resistance to flow always decreases downslope. This is a result of low flows following pathways formed by higher flows that concentrate downslope. Analyses of overland flow hydraulics at the scale of interrill areas produce results that are quite different from those obtained from small plots. A knowledge of the hydraulics at this scale is essential if models of interrill overland flow are to become more realistic and, hence better predictors of runoff hydrographs and sediment yield. (Author's abstract)
W91-03552

COMPUTATION OF THE INSTANTANEOUS UNIT HYDROGRAPH AND IDENTIFIABLE COMPONENT FLOWS WITH APPLICATION TO TWO SMALL UPLAND CATCHMENTS.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
A. J. Jakeman, I. G. Littlewood, and P. G. Whitehead.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 275-300, September 1990. 10 fig, 6 tab, 43 ref, append.

Descriptors: *Hydrographs, *Hydrological models, *Instantaneous unit hydrographs, *Model studies, *Rainfall-runoff relationships, *Streamflow, *Streamflow forecasting, *Unit hydrographs, Climatic data, Excess rainfall, Precipitation, Rainfall, Small watersheds, Wales, Watersheds.

A model for relating data on rainfall and other climatic variables to streamflow was presented. The approach is based upon three factors: (1) the representation of total streamflow response as a linear convolution of the instantaneous unit hydrograph with rainfall excess; (2) approximation of this representation in discrete time by a rational transfer function relationship which involves an efficient and flexible parameterization; and (3) use of a simple refined version of the instrumental variable method of parameter estimation as the major tool to determine the number of identifiable flow components in the representation and to estimate their dynamic contributions to the instantaneous unit hydrograph. Stream hydrograph separation is undertaken by convoluting rainfall excess with the identified components of the unit hydrograph. The procedure was applied to two small catchments in Wales. The results demonstrate that at sampling intervals of the order of one hour, successful separation of quick and slow flow components can be achieved with short time series of rainfall and streamflow. (Author's abstract)
W91-03553

COMPARATIVE EVALUATION OF THE ESTIMATORS OF THE LOG PEARSON TYPE (LP) 3 DISTRIBUTION.
Saint Johns River Water Management District, Palatka, FL. Dept. of Surface Water Programs.
For primary bibliographic entry see Field 7C.
W91-03557

SECOND CONFERENCE ON THE MANAGEMENT OF THE ILLINOIS RIVER SYSTEM: THE 1990S AND BEYOND.
For primary bibliographic entry see Field 6A.
W91-03608

COMPARISON OF COMMERCIAL-COMMODITY AND RECREATIONAL USE OF THE ILLINOIS RIVER SYSTEM: THE CASE OF THE ILLINOIS AND MICHIGAN NATIONAL HERITAGE CANAL CORRIDOR.
Illinois Univ. at Urbana-Champaign. Inst. for Environmental Studies.
For primary bibliographic entry see Field 6E.
W91-03628

ILLINOIS RIVER AND THE U.S. CORP OF ENGINEERS.
Army Engineer District, Rock Island, IL.
For primary bibliographic entry see Field 6A.
W91-03632

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY.
Geological Survey, Charleston, WV. Water Resources Div.
D. H. Appel.
Available from Books and Open File Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 90-150, 1990. 46p.

Descriptors: *Data acquisition, *Geological surveys, *Groundwater, *Surface water, *Water resources, *Water resources data, *Water resources institutes, *West Virginia, Federal jurisdiction, Hydrologic data, Institutions.

The U.S. Geological Survey (USGS) has been active in West Virginia since the early 1900's. During recent years, the District completed several investigations as well as initiated others. An intense effort has been made to publish interpretive reports and data on a near-current basis. As a result of this effort, a significant number of water resources reports were completed and/or published during the 1989 fiscal year. This report contains a complete list of USGS reports addressing West Virginia hydrology as of December 1989. The mission of the Water Resources Division is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people in the United States. This is accomplished, in large part, through cooperation with other Federal and non-Federal agencies, by: (1) Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources; (2) Conducting analytical and interpretive water resource appraisals describing the occurrence, availability, and the physical, chemical, and biological characteristics of surface and groundwater; (3) conducting supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science to improve the scientific basis for investigations and measurement techniques and to understand hydrologic systems sufficiently well to quantitatively predict their response to stress, either natural or manmade; (4) disseminating the water data and the results of these investigations and research through reports, maps, computerized information services, and other forms of public releases; (5) Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and groundwaters; and (6) Providing scientific and technical assistance in hydrologic fields to other Federal, State and local agencies, to licensees of the Federal Power Commission, and to international agencies on behalf of the Department of State. (Lantz-PTT)
W91-03663

DETERMINATION OF AN UPPER LIMIT DESIGN RAINSTORM FOR THE COLORADO RIVER BASIN ABOVE HOOVER DAM.
Morrison-Knudsen Engineers, Inc., Denver, CO.
For primary bibliographic entry see Field 2B.
W91-03664

INITIAL CONTRIBUTING AREA OF A SMALL WATERSHED.
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
W. J. Gburek.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 387-403, October 1990. 10 fig, 37 ref.

Descriptors: *Hydrographs, *Rainfall-runoff relationships, *Simulation analysis, *Surface runoff, *Watersheds, Base flow, Infiltration, Pennsylvania, Rainfall area, Saturation zone, Stream discharge.

The initial contributing area (ICA) of a watershed at the onset of rain is defined as consisting of the stream surface and the area of surface saturation caused by the groundwater table intersecting the land surface above the elevation of the stream. Subsurface flow discharges upward within this area, so the ICA exhibits zero infiltration capacity and potential storage for rainfall. Thus, the ICA is the initial runoff-producing area in variable-source-area generation of storm runoff. The ICA of a 42-ha east-central Pennsylvania watershed was shown to be a function of prestorm base flow; a prediction equation was developed using rainfall-runoff data from small rainstorms. This equation could be incorporated directly into a continuous streamflow model where a base flow value is part of the simulation, or into an event-based hydrograph model where prestorm baseflow is specified as a design parameter. (Author's abstract)
W91-03760

RESPONSES OF PERIPHYTON TO CHANGES IN CURRENT VELOCITY, SUSPENDED SEDIMENT AND PHOSPHORUS CONCENTRATION.
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W91-03820

FIRE AND THE DYNAMICS OF ALLOCHTHONOUS DETRITUS IN A SOUTH AFRICAN MOUNTAIN STREAM.
Cape Town Univ. (South Africa). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W91-03826

MATHEMATICAL MODELS FOR LONG-TERM PREDICTION OF MOUNTAINOUS RIVER RUNOFF: METHODS, INFORMATION AND RESULTS.
Sredneaziatskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Inst., Tashkent (USSR).
I. D. Shentzis.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 5, p 487-500, October 1990. 8 fig, 2 tab, 6 ref.

Descriptors: *Hydrologic models, *Mathematical models, *Model studies, *Mountains, *River flow, *Runoff forecasting, *Streamflow forecasting, *Surface runoff, Glacial streams, Hydrologic budget, Mathematical analysis, Mountain streams, Soviet Union.

The insufficient accuracy of traditional statistical methods has led to the development of a method for the long-term forecasting of runoff in the Central Asian mountainous rivers for the vegetation period, based on a mathematical model. The model describes the whole cycle of runoff formation in mountainous river basins reflecting processes and factors such as precipitation within the various mountain zones, snow cover formation and levels, glaciation, evaporation, and water storage and transport. Testing of the method for the rivers of the Fergana Valley and western Tien Shan has shown that the new model exhibits greater accuracy than the operational statistical forecast method. This is especially true concerning corrections to the forecast in April-May, when the accuracy of estimates of temporary basin storage becomes most important. In addition, numerical experiments revealed that ignorance of glaciation which makes up 3-5% of the total area of mountainous basins leads to considerable errors of summer runoff forecasts. That is why a component for glacial runoff computation was introduced into the model. Consideration of glacial alimentation has eventually improved the estimation of model computation, and forecasts of mountainous river runoff. (Hoskin-PTT)
W91-03840

COMPARISON OF DIFFERENT STRUCTURES FOR A MONTHLY WATER YIELD MODEL IN SEASONALLY SNOW-COVERED MOUNTAINOUS WATERSHEDS OF IRAN.
Katholieke Univ. Leuven (Belgium). Lab. for Land Management.
M. Moussavi, J. Feyen, and G. Wyseure.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 5, p 535-546, October 1990. 6 fig, 3 tab, 10 ref.

Descriptors: *Iran, *Model studies, *Mountains, *Runoff, *Runoff forecasting, *Snow cover, *Snowmelt, *Streamflow forecasting, *Water yield, Comparison studies, Hydrologic budget, Hydrologic models, Mathematical analysis, Mathematical models, Surface runoff.

In many countries the data available in mountainous watersheds are rare and sometimes the required data are accessible only in monthly time steps or as average daily values over a given month. This study emphasizes the search for an appropriate structure of a monthly water balance model, in conjunction with a nonlinear parameter estimation algorithm, capable of simulating the monthly streamflow in seasonally snow-covered mountainous watersheds, and requiring a minimum number of parameters and amount of input data. Several model structures based on a soil water balance concept were compared for the Rudak catchment of Iran. The main distinction between the different structures was made by the inclusion of either a linear or a nonlinear transformation element for the conversion of overland flow or baseflow into total runoff. A combined water balance model having two main elements, a soil storage element generating excess water, and a transformation element conceptualized by a linear storage-discharge relationship (a linear lumped conceptual model), was found to be the most accurate.

The integration of a nonlinear storage-discharge relationship which leads to a second order nonlinear model did not prove to be more successful than a linear or nonlinear first order element. (Hoskin-PTT)
W91-03844

DAM SAFETY: AN EVALUATION OF SOME PROCEDURES FOR DESIGN FLOOD ESTIMATION.
Salford Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W91-03845

CLIMATE FACTOR FOR SMALL-BASIN FLOOD FREQUENCY.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 2A.
W91-03853

DISTRIBUTED DYNAMIC WATERSHED MODEL.
Texas A and M Univ., College Station.
W. P. James, and K. W. Kim.
Water Resources Bulletin WARBAQ, Vol. 26, No. 4, p 587-596, August 1990. 9 fig, 3 tab, 20 ref.

Descriptors: *Hydrologic models, *Mathematical models, *Model studies, *Overland flow, *Rainfall-runoff relationships, *Runoff forecasting, *Simulation analysis, *Watershed models, Data interpretation, Drainage patterns, Mathematical analysis, Mathematical equations, Surface drainage.

A distributed watershed model was developed to mathematically simulate overland and channel flow for a single-event storm. The modeled watersheds in the study were subdivided into rectangular grid elements. All hydrologically significant parameters, such as land slope, rainfall and precipitation excess, were assumed to be uniform within each element. The Green-Ampt method was adopted to generate precipitation excess for each element during the simulation period. A two-dimensional diffusion wave model was used for overland flow routing and an iterative Alternative Direction Implicit scheme was used to solve the simultaneous overland flow equations. Once the overland flow became inflow to the channel, a one-dimensional dynamic wave flood routing technique, based on a four-point, implicit, non-linear finite difference solution of the St. Venant equation of unsteady flow, was applied. A limited number of comparisons were made between simulated and observed hydrographs for areas of about one square mile. Given the appropriate parameters, the model was able to accurately simulate runoff for single-event storms. Comparisons were made between simulated and observed hydrographs for three watersheds. The model was able to accurately simulate the runoff for single-event storms using 61-m by 61-m (200 ft by 200 ft) watershed grid elements. (Author's abstract)
W91-03854

LINEAR PROGRAMS FOR NONLINEAR HYDROLOGIC ESTIMATION.
California Univ., Santa Barbara. Dept. of Geography.
H. A. Loaiciga, and R. L. Church.
Water Resources Bulletin WARBAQ, Vol. 26, No. 4, p 645-656, August 1990. 5 tab, 18 ref. California Water Resources Center Grant W-752.

Descriptors: *Hydrologic models, *Linear programming, *Mathematical equations, *Mathematical models, *Model studies, *Rainfall-runoff relationships, *Runoff forecasting, Hydrology, Mathematical analysis, Regression analysis, Runoff, Surface runoff.

The process of calibrating a hydrologic model is of great importance in applied hydrologic studies. The minimization of the sum of absolute deviations and the minimization of the absolute maximum deviation (minimax) have been transformed into equivalent linear programs for the estimation of parameters in a transient and linear hydrologic system. These two methods yield viable parameter estimates that are globally optimal and reproduce properly the timing and magnitude of hydrologic events and associated variables such as total runoff, flood peak and peak-flood magnitude. The two linear estimation methods compared favorably with the popular least-squares nonlinear estimation method. The generality of the theoretical developments shows that linear program equivalents are adequate competitors of nonlinear methods of hydrologic estimation and parameter calibration. (Hoskin-PTT)
W91-03859

ADDITIONAL ANALYSIS OF PEAK-VOLUME RELATIONS AND STANDARDIZATION PROCEDURES.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
M. E. Molfino, and J. F. Cruise.
Water Resources Bulletin WARBAQ, Vol. 26, No. 4, p 687-692, August 1990. 1 fig, 2 tab, 11 ref.

Descriptors: *Flood hydrographs, *Flood peak, *Hydrologic models, *Mathematical equations, *Model studies, *Peak flow, *Rainfall-runoff relationships, *Runoff forecasting, Hydrology, Mathematical analysis, Mathematical models, Regression analysis, Slopes.

Much has been written about the linear relationship in log space between the runoff volume of a hydrograph and the peak discharge. Three versions of this relation (an original and two standardizations) have been presented and recommended by various authors. The standardized equations were compared to the original relationship and the behavior of the coefficient of determination (r2) in each case is discussed. The r2 of the standardized equations is increased or decreased relative to that of the original relation based upon the magnitude of the original slope. A database of 90 watersheds and over 1200 separate flood hydrographs were used to investigate the comparative utility of these equations. (Author's abstract)
W91-03863

WINTER SHORT-PULSE RADAR STUDIES ON THE TANANA RIVER, ALASKA.
Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 7B.
W91-03868

COLLAPSE OF RIPARIAN POPLAR FORESTS DOWNSTREAM FROM DAMS IN WESTERN PRAIRIES: PROBABLE CAUSES AND PROSPECTS FOR MITIGATION.
Lethbridge Univ. (Alberta). Dept. of Biological Sciences.
For primary bibliographic entry see Field 6G.
W91-03876

PALYNOSTRATIGRAPHY OF THE CENTRAL WEST MURRAY BASIN.
M. K. Macphail, and E. M. Truswell.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 301-331, 1990. 11 fig, 1 tab, 75 ref, 2 append.

Descriptors: *Australia, *Geohydrology, *Geologic history, *Murray-Darling River Basin, *Paleohydrology, *Palynology, Aquitards, Boreholes, Geologic control, Groundwater, Marine environment, Paleoclimatology, Pollen, Rainfall, River basins, Stratigraphy, Vegetation.

Palynological analyses have been undertaken on four boreholes in the central west Murray Basin, in southeastern Australia, to provide a biostratigraphic framework for geological factors related to groundwater. Three of the boreholes penetrated the marine sequence of the Geera Clay, which acts as an aquitard confining groundwater flow within the aquifers of the Renmark Group. The oldest sediments encountered in this study were early Cretaceous (non-marine); followed by marine transgressions during the middle Eocene-early Oligocene and Oligocene-early/middle Miocene (Geera Clay deposition). Pollen assemblages from the Murray Basin contain a number of taxa, many of them with affinities to modern tropical plant species or groups which are unknown in other southeastern Australian basins. Many of these are of potential stratigraphic value. Broad scale shifts in vegetation, presumably in response to climatic change, are discernible in the Late Oligocene to earliest Miocene over much of the basin. There is a suggestion that the initiation of this shift, which reflects a change from year-round to seasonal rainfall patterns, was diachronous for west to east, but patterns of change in space and time are complex, so the correlative value of changes in pollen frequencies remains limited. (Author's abstract)
W91-03904

2F. Groundwater

GEOLOGY AND GROUND-WATER RESOURCES OF THE SAN CARLOS INDIAN RESERVATION, GILA, GRAHAM, AND PINAL COUNTIES, ARIZONA.
Geological Survey, Tucson, AZ. Water Resources Div.
J. G. Brown.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4152, 1989. 39p, 5 fig, 2 plates, 4 tab, 32 ref. Project no. AZ112.

Descriptors: *Alluvial aquifers, *Arizona, *Geohydrology, *Groundwater availability, *San Carlos Indian Reservation, Alluvium deposits, Basin-fill deposits, Specific yield, Transmissivity, Volcanic rocks, Water quality.

The San Carlos Indian Reservation includes about 2,900 sq mi in east-central Arizona. Relatively impermeable pre-Tertiary rocks are exposed in about 23% of the reservation and underlie water-bearing Tertiary and quaternary basin fill and Quaternary stream alluvium in much of the southern part of the reservation. About 9,000 members of the San Carlos Apache Tribe live on the reservation and rely on groundwater to meet public supply, irrigation, and other needs. Basin fill is widespread in the valley of the San Carlos and Gila Rivers and consists of fine sand, silt, limestone, clay, and pyroclastic volcanics that may attain a total maximum thickness of more than 3,200 ft in the reservation. Quaternary stream alluvium overlies the basin fill along many streams and washes. Stream alluvium consists of poorly sorted, unconsolidated, gravelly, muddy, sand; and sandy gravel and reaches a maximum thickness of 100 ft along the San Carlos and Gila Rivers. The volume of recoverable water stored in the basin fill to a depth of 1,200 ft is estimated to be about 20 million acre-ft. The volume of recoverable water stored in the stream alluvium on the reservation is estimated to be more than 100,000 acre-ft. The stream alluvium along the San Carlos River supplies most of the water used for drinking. Water throughout much of the reservation is suitable for most uses except for that in the alluvium along the Gila River, which contains large concentrations of dissolved solids. (USGS)
W91-02961

POTENTIOMETRIC SURFACE OF THE MAGOTHY AQUIFER IN SOUTHERN MARYLAND DURING SEPTEMBER 1988.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-02962

HYDROGEOLOGIC AND CHEMICAL DATA FOR THE O-FIELD AREA, ABERDEEN PROVING GROUND, MARYLAND.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 5B.
W91-02964

HYDROGEOLOGIC DATA FOR THE CANAL CREEK AREA, ABERDEEN PROVING GROUND, MARYLAND, APRIL 1986-MARCH 1988.
Geological Survey, Towson, MD. Water Resources Div.
J. P. Oliveros, and P. Gernhardt.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-387, 1989. 71p, 29 fig, 3 tab, 4 ref.

Descriptors: *Aberdeen Proving Ground, *Aquifer characteristics, *Aquifer systems, *Coastal aquifers, *Hydrologic data, *Maryland, Groundwater, Unconsolidated aquifers, Water level.

This report is a compilation of hydrologic and geologic data collected for the period April 1986 through March 1988 for the Canal Creek area of Aberdeen Proving Ground, Maryland. Geologic data include lithologic logs for 73 sites and geophysical logs for 71 sites. Hydrologic data consist of hydrographs and synoptic water level measurements. The hydrographs were taken from eight wells that were equipped with continuous water level recorders, and the synoptic water-level measurements were made four times during the study. Well-construction data also are included for 149 observation wells. (USGS)
W91-02965

GEOHYDROLOGY AND NUMERICAL MODEL ANALYSIS OF GROUND-WATER FLOW IN THE PULLMAN-MOSCOW AREA, WASHINGTON AND IDAHO.
Geological Survey, Tacoma, WA. Water Resources Div.
W. E. Lum, J. L. Smoot, and D. R. Ralston.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4103, 1990. 73p, 27 fig, 7 tab, 42 ref.

Descriptors: *Basalts, *Computer models, *Geohydrology, *Groundwater movement, *Loess, *Model studies, Aquifers, Groundwater, Groundwater budget, Groundwater depletion, Groundwater management, Hydraulic conductivity, Recharge, Seepage, Simulation, Storage coefficient, Surface-groundwater relations.

The geohydrology of the Pullman, Washington-Moscow, Idaho area was investigated by mapping geohydrologic units, determining the distribution of hydraulic head in each unit, and determining some of the components of the water budget. This information was used to construct a three-dimensional groundwater-flow model that incorporates three layers--a surficial loess layer, a Wanapum Basalt layer, and a Grande Ronde Basalt layer. The model was used to assess the effects of changes in the rate of withdrawal of groundwater on the water levels in the geohydrologic units and on streamflow in the area. Recharge to the groundwater system was calculated independent of the model. It was determined that current farming practices use soil moisture more effectively than did natural vegetation, and these practices have reduced groundwater recharge by nearly 10%. The three-dimensional model was calibrated using the time-averaged method for the period 1974-85, and was evaluated by simulating historical pumpage rate changes (1890-1985) and comparing calculated with observed water-level changes. Model results indicate that groundwater levels would stop declining if pumpage were stabilized at a constant level. Levels will continue to decline into the foreseeable future, however, as long as groundwater pumpage continues to increase. The source of the additional simulated pumpage is streamflow depletion near pumping locations. (USGS)
W91-02970

HYDROGEOLOGY AND WATER RESOURCES OF THE LOS OSOS VALLEY GROUNDWATER BASIN, SAN LUIS OBISPO COUNTY.
Geological Survey, Sacramento, CA. Water Resources Div.
E. B. Yates, and J. H. Wiese.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4081, May 1990. 76p, 29 fig, 8 tab, 35 ref.

Descriptors: *Geohydrology, *Groundwater, *Groundwater movement, *Los Osos Valley, *Model studies, *Wastewater disposal, *Water pollution control, California, Groundwater management, Hydrogeology, Recharge, Saline water intrusion, San Luis Obispo County, Seawater, Simulation.

The Los Osos Valley groundwater basin on the central California coast extends about 3 miles inland and an unknown distance offshore, where it is hydraulically connected with the Pacific Ocean. Basin fill consists of unconsolidated, complexly layered sediments; individual beds are thin and discontinuous. Groundwater flow was studied using available data, geologic mapping, drilling, and measurements of potentiometric head, water quality, and streamflow. A three-dimensional digital model of the basin was developed and calibrated to match water levels and head-dependent flows during 1970-77 and 1986. Although the model could not simulate perched water tables, other results were adequate and were not sensitive to small errors in input data. Annual recharge comes from rainfall (80%), groundwater inflow (18%), and net recharge from Los Osos Creek (2%). In 1986, principal outflows were net municipal pumpage (34%), net agricultural pumpage (28%), and net outflow across the ocean boundary (28%). Model simulations of water supply and wastewater disposal options indicated that if wastewater is centrally treated and recharged, locally pumped groundwater could meet projected municipal water demand through the year 2010 without causing seawater intrusion, even during brief droughts. If wastewater is exported from the basin, seawater intrusion is likely even if imported water meets approximately half of municipal water demand in the 2010. Wastewater recharge may cause long-term salt buildup in the basin and local waterlogging of soils. (USGS)
W91-02971

MAP OF MEAN ANNUAL RUNOFF FOR THE NORTHEASTERN, SOUTHEASTERN, AND MID-ATLANTIC UNITED STATES, WATER YEARS 1951-80.
Geological Survey, Madison, WI. Water Resources Div.
W. R. Krug, W. A. Gebert, and D. J. Graczyk.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4094, 1990. 11p, 2 fig, 1 pl, 6 tab, 5 ref.

Descriptors: *Data collections, *Hydrologic data, *Maps, *Runoff, *Stream discharge, *Water resources data, Gaging stations.

A map of mean annual runoff for States within the Northeastern, Southeastern, and Mid-Atlantic United States was prepared by the U.S. Geological Survey for the Direct/Delayed Response Project being conducted by the U.S. Environmental Protection Agency. This map shows mean annual runoff during water years 1951-80. Mean annual runoff from the northeastern region during 1951-80 ranged from less than 12 to greater than 40 inches. Runoff from the southeastern region runoff ranged from less than 12 to greater than 55 inches. In the mid-Atlantic region ranged from less than 10 to greater than 40 inches. Error analysis using 93 gaging stations not used for preparing the runoff map showed that the runoff map could be used to predict runoff with an average error of less than 10%. Errors in runoff estimation averaged about 12% if the locations of the gaging stations were used to estimate runoff instead of computing an area-weighted average over the basin. If the locations of the gaging stations were used to estimate runoff, there also was a significant negative bias of the errors that did not occur if the centroid or a weighted average runoff of the drainage basin were used. The runoff map is expected to be more accurate in areas that have a relatively high concentration of gaging stations and little topographic variability, such as part of the Northeast. Based on these criteria, the least reliably mapped areas would be in the Smokey Mountains along the North Carolina-Tennessee border. (USGS)
W91-02973

PLAN OF STUDY FOR THE OHIO-INDIANA CARBONATE-BEDROCK AND GLACIAL-AQUIFER SYSTEM.
Geological Survey, Columbus, OH. Water Resources Div.
E. F. Bugliosi.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-151, 1990. 27p, 10 fig, 23 ref.

Descriptors: *Aquifer characteristics, *Aquifers, *Geohydrology, *Glacial aquifers, *Groundwater, *Indiana, *Ohio, Aquifer systems, Carbonate rocks, Water use.

The major aquifers of 35,000 sq mi area in western Ohio and eastern Indiana consist of Silurian and Devonian carbonate bedrock and Quaternary glacial deposits. These bedrock units and glacial deposits have been designated for study as part of the U.S. Geological Survey's Regional Aquifer System Analysis program, a nationwide program to assess the regional hydrology, geology and water quality of the Nation's most important aquifers. The purpose of the study is to define the hydrology, geochemistry, and geologic framework of the aquifer system within the Silurian and Devonian rocks and glacial deposits, with emphasis on describing the groundwater flow patterns and characterizing the water quality. The study, which began in 1988, is expected to be completed in 1993. In 1980, the aquifers in the study area supplied more than 280 million gallons of water/day to industry, agriculture, and a population of more than 6.3 million people. With a projected future population growth to 7.1 million in 1990, and with intensified agricultural and industrial uses, water withdrawals from these bedrock and glacial aquifers are expected to be increased. The most significant groundwater problems in the study area result from the pronounced areal differences in availability and quality of the groundwater. These differences are related to the lateral discontinuity of many of the glacial deposits and to variations in secondary permeability of the bedrock aquifers associated with patterns of fracturing. Planned activities of the study include compilation of available geohydrologic and water quality data, such as groundwater levels, geohydrologic properties of aquifers, chemical analyses, land use and water use data, and ancillary data such as digital satellite images. Additional geohydrologic and water quality data may be collected from existing wells or wells that may be drilled for this study. A computerized, geographic information system will be used as a data base management tool and for spatial analysis and presentation of the data. A digital computer model will be developed to study the regional groundwater flow system and to investigate the effects of development on the aquifer system. (USGS)
W91-02975

SIMULATION OF GROUND-WATER FLOW IN THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER IN EASTERN ARKANSAS.
Geological Survey, Little Rock, AR. Water Resources Div.
G. L. Mahon, and A. H. Ludwig.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4145, June 1990. 26p, 10 fig, 25 ref.

Descriptors: *Alluvial aquifers, *Arkansas, *Computer models, *Geohydrology, *Groundwater movement, *Mississippi-Missouri River Valley, *Model studies, *Pumpage, Hydraulic properties, Recharge, Rivers, Storage coefficient, Transmissivity.

The U.S Geological Survey has developed and calibrated a digital model of the flow system in the alluvial aquifer as part of a multiagency Eastern Arkansas Region Comprehensive Study being conducted by the U. S. Army Corps of Engineers. Other cooperating agencies include the U.S. Soil

Conservation Service, the Arkansas Soil and Water Conservation Commission, and the University of Arkansas. The study was prompted by the growing concern about significant water level declines in the Mississippi River Valley alluvial aquifer north of the Arkansas River in eastern Arkansas. The declines are a result of large groundwater withdrawals, mainly for irrigation. After calibration, the flow model was used to simulate the effects of projected groundwater pumpage through the year 2050, based on estimates made by the U.S. Soil Conservation Service for pumpage scenarios with and without water conservation measures. Simulations of projected pumpage indicated that by the year 2050 water level declines would reduce the saturated thickness of the aquifer to less than 20 ft in large areas of eastern Arkansas. More than 26% of the active cells in the scenario without conservation had saturated thicknesses of 20 ft or less and mroe than 16% in the scenario with conservation. The principal areas where the saturated thickness is expected to reach these critical levels are in the Grand Prairie region and in two areas on the east and west sides of Crowleys Ridge. (USGS)
W91-02976

EVALUATION OF GROUND-WATER RECHARGE ALONG THE GILA RIVER AS A RESULT OF THE FLOOD OF OCTOBER 1983, IN AND NEAR THE GILA RIVER INDIAN RESERVATION, MARICOPA AND PINAL COUNTIES, ARIZONA.
Geological Survey, Tucson, AZ. Water Resources Div.
A. D. Konieczki, and S. R. Anderson.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4148, 1990. 30p, 6 fig, 7 tab, 2 plates, 23 ref. Project No. AZ090.

Descriptors: *Arizona, *Gila River, *Groundwater resources, *Recharge, *Surface-groundwater relations, Gila River Indian Reservation, Maricopa County, Pinal County.

Flow in the Gila River from the flood of October 1983 infiltrated the stream channel and recharged the groundwater system along the Gila River floodplain from Ashurst-Hayden Dam to the confluence with the Salt River. Changes in groundwater levels from January 1983 to March 1984 confirmed the occurrence of recharge to the groundwater system. The average water level change for 74 wells was +24.2 ft. The water-level rise was greatest in the reach from river mile 15 to river mile 22, where the average water level change for 10 wells was +59.4 ft. The average water level increase for 28 miles from river mile 40 to river mile 71 was +14.2 ft. Estimates of recharge from January 1983 to March 1984 ranged from 440,000 to 640,000 acre-ft. A water budget method and a water level change method were used to estimate the recharge to the aquifer. At least 46% to 66% of the recharge was the result of streamflow infiltration from the Gila River during October 1983 to February 1984. The increase in aquifer storage was one to two times greater than the quantity of groundwater pumped from the Gila River Indian Reservation during the 10 years preceding the flood. (USGS)
W91-02977

LARGE SPRINGS IN THE VALLEY AND RIDGE PROVINCE IN TENNESSEE.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-02979

STRUCTURE AND APPLICATION OF AN INTERFACE PROGRAM BETWEEN A GEOGRAPHIC-INFORMATION SYSTEM AND A GROUNDWATER FLOW MODEL.
Geological Survey, Tucson, AZ. Water Resources Div.
P. C. Van Metre.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-165, 1990. 68p, 2 fig, 4 ref. Project No. AZ104.

Descriptors: *Computer models, *Computer programs, *Geographic information systems, *Groundwater movement, *Model studies, Computers, Geographical information systems.

A computer-program interface between a geographic-information system and a groundwater flow model links two unrelated software systems for use in developing the flow models. The interface program allows the modeler to compile and manage geographic components of a groundwater model within the geographic information system. A significant savings of time and effort is realized in developing, calibrating, and displaying the groundwater flow model. Four major guidelines were followed in developing the interface program: (1) no changes to the groundwater flow model code were to be made; (2) a data structure was to be designed within the geographic information system that follows the same basic data structure as the groundwater flow model; (3) the interface program was to be flexible enough to support all basic data options available within the model; and (4) the interface program was to be as efficient as possible in terms of computer time used and online-storage space needed. Because some programs in the interface are written in control-program language, the interface will run only on a computer with the PRIMOS operating system. (USGS)
W91-02980

CONSIDERATIONS FOR DATA COLLECTION TO SUPPORT SIMULATION ANALYSES IN THE SATURATED ZONE.
For primary bibliographic entry see Field 7A.
W91-02994

NATIONAL WATER INFORMATION SYSTEM USER'S MANUAL. VOLUME 2, CHAPTER 4. GROUND-WATER SITE INVENTORY SYSTEM.
For primary bibliographic entry see Field 7C.
W91-03013

40 CFR 265 INTERIM STATUS INDICATOR-EVALUATION GROUND-WATER MONITORING PLAN FOR THE 216-B-63 TRENCH.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 7A.
W91-03024

GUIDANCE ON REMEDIAL ACTIONS FOR CONTAMINATED GROUND WATER AT SUPERFUND SITES.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-03031

MINIMUM SET OF DATA ELEMENTS FOR GROUND WATER.
Environmental Protection Agency, Washington, DC. Information Management and Services Div.
For primary bibliographic entry see Field 7A.
W91-03044

AQUIFER PROPERTIES DATABASE.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 7C.
W91-03046

INCREASING THE VALUE OF TECHNICAL DATA FOR MAKING GROUNDWATER POLICY DECISIONS.
North Carolina State Univ., Raleigh. Dept. of Economics.
For primary bibliographic entry see Field 7B.
W91-03075

GROUND WATER MODELING ANALYSIS FOR A CONTAMINATED WATER-SUPPLY WELL FIELD IN INDIANA.
Weston (Roy F.), Inc., West Chester, PA.
J. Y. Yang.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 13A-11--13A-18, 7 ref.

Descriptors: *Groundwater pollution, *Groundwater quality, *Indiana, *Model studies, *Monitoring, *Path of pollutants, *Water supply, Solute transport, Trichloroethylene, Volatile organic compounds, Wells.

Trichloroethylene (TCE) contamination was found in a well field in Indiana which provided more than 1,300 million gallons a year for domestic water supply purposes. The initial discovery of TCE contamination occurred in April 1981, during routine testing of finished water by the EPA. All 15 production wells in the well field have shown measurable levels of TCE and other volatile organic compounds (VOCs). Seven of the 15 wells have shown annual average TCE concentrations greater than EPAs safe allowable limit of 5.0 ppb. Some industrial wells, which yield more than 100,000 gpd and are located within 1 mile west of the well field, have been developed in the same unconsolidated sand and gravel deposits. A two-dimensional, numerical groundwater solute transport model was developed and used to evaluate TCE migration in the groundwater system beneath the well field. The preliminary results indicated locations of potential sources of contamination and indicated that additional monitoring wells should be drilled for data collection. (See also W91-03032) (Author's abstract)
W91-03081

DROUGHT MANAGEMENT PLAN: MANAGING AND PROTECTING A RESOURCE.
Camp, Dresser and McKee, Inc., Austin, TX.
For primary bibliographic entry see Field 4B.
W91-03089

BENCH-SCALE STUDY OF THE REMOVAL OF CHROMIUM AND CYANIDE FROM CONTAMINATED GROUNDWATER.
For primary bibliographic entry see Field 5G.
W91-03102

APPROPRIATE METHODOLOGIES FOR DEVELOPMENT AND MANAGEMENT OF GROUNDWATER RESOURCES IN DEVELOPING COUNTRIES. VOLUME III.
Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. 324p. Edited by C. P. Gupta.

Descriptors: *Developing countries, *Geohydrology, *Groundwater management, *Water resources development, *Water resources management, *Workshops, Analytical methods, Groundwater movement, Groundwater potential, Hydrologic models, Management planning, Model studies, Publications, Water demand.

The keynote papers and other significant contributions of an international workshop deliberating on the state-of-the-art techniques in geohydrology and their illustrative applications have been compiled into a series of publications. In the third volume, some of the articles are a critical review/overview of the established techniques, though with a new insight, such as estimation of geohydrological situations. Some others deal with techniques that are known, but not commonly used in geohydrological studies, such as the use of radon in exploration in fractured zones, three-dimensional stochastic modeling for fractured media, and use of cross validation in krigings. The papers have been organized in the same sequence of sessions as in Volumes I and II of this workshop. It is expected that these thought-provoking papers will lead to interactive and purposeful discussions and finally help solidify the operational details, technical guidelines, designs, and practices for hazard-free exploration, exploitation, and management of groundwater resources to meet the ever-increasing demand for water. (See W91-03179 thru W91-03197) (Fish-PTT)

W91-03178

GEOHYDROLOGIC PARAMETER ESTIMATION: PUMPING TESTS AND TRACER TECHNIQUES.
Birmingham Univ. (England). Dept. of Civil Engineering.
K. R. Rushton.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 1-21, 9 fig, 1 tab, 34 ref.

Descriptors: *Developing countries, *Geohydrology, *Groundwater management, *Hydrologic models, *Model studies, *Parametric hydrology, *Tracers, *Water resources management, Analytical methods, Aquifer characteristics, Aquifer testing, Groundwater movement, Groundwater potential, Management planning, Numerical analysis, Research priorities, Water resources development.

Estimation of the parameters which describe groundwater flow continues to be an important area of research. The recommended approach is to identify the important flow mechanisms before attempting to analyze any pumping tests. In field examples initial studies did not identify the mechanisms that would apply as exploitation of the aquifers developed; for this reason the potential yields of the aquifers were overestimated. It is necessary to carry out controlled tests and select suitable methods of analysis to estimate the magnitude of the aquifer parameters. Numerical analysis is becoming increasingly feasible, since the programs run successfully on microcomputers. The most difficult parameter to estimate is the effective vertical hydraulic conductivity. At present the only reliable method is using carefully-designed pumping tests with analytical or numerical methods of analysis. The development of a more direct method of determining the effective vertical hydraulic conductivity must have a high priority. Tracers are used to learn more about aquifer features, especially the recharge. The techniques which have been developed are reliable and consistent yet there remains the uncertainty as to whether measurements in the unsaturated zone can give reliable information about the quantity of water actually reaching the water table. There are in effect pumping tests and recharge experiments occurring continuously in most aquifers. If records are kept of inflows, well discharges, groundwater hydrographs, and river flows, these can be used with some form of regional or local groundwater model to estimate the important groundwater parameters. (See also W91-03178) (Fish-PTT)
W91-03179

PROGRESS AND PROSPECTS IN ENVIRONMENTAL ISOTOPE HYDROLOGY.
Niedersaechsisches Landesamt fuer Bodenforschung, Hanover (Germany, F.R.)
M. A. Geyh.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 23-36, 8 fig, 1 tab, 43 ref.

Descriptors: *Developing countries, *Environmental tracers, *Groundwater movement, *Isotopic tracers, *Tracers, *Water resources development, Analytical methods, Arid-zone hydrology, Groundwater management, Groundwater potential, Hydrologic models, Management planning, Model studies, Radioisotopes, Semiarid lands, Water resources management.

In recent years various techniques based on environmental isotopes have been widely applied in hydrological studies. Most commonly analyzed are the isotope compositions of the environmental radionuclides tritium and radiocarbon as well as those of the stable nuclides of oxygen and hydrogen. The environmental isotope techniques allow determination of the origin of groundwater, its recharge and discharge, quantification of mixtures of different kinds of groundwater, estimation of the age of groundwater, and its movement. New hydrological chronometers such as chlorine-36, argon-39, calcium-41, krypton-81, and krypton-85, as well as the dissolved noble gases, have been introduced during recent years. The dating of groundwater via its dissolved organic carbon compounds seems to be promising. In semiarid and arid zones the estimation of very small evaporation rates from the stable isotope composition of pore water in profiles of the unsaturated zone has become important in groundwater balance studies. There is a trend substituting qualitative for quantitative interpretation of environmental isotope data using mass transport calculations. It has been shown, for instance, that the occurrence of relict resources of fossil groundwater in semiarid zones complicate numerical modeling. Last but not least, long-term monitoring of the isotope composition in groundwater abstracted from production wells may yield recommendations for an optimized groundwater management program. (See also W91-03178) (Author's abstract)
W91-03180

NATURAL RECHARGE OF BASEMENT AQUIFERS IN A SAHEL AND SUDAN CLIMATE: EXPERIMENTAL STUDY IN BURKINA FASO.
Bureau de Recherches Geologiques et Minieres, Orleans (France).
F. Milville, M. Normand, T. Pointet, C. Merlo, and F. Urani.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 47-61, 5 fig, 3 tab, 4 ref.

Descriptors: *Africa, *Burkina Faso, *Developing countries, *Geohydrology, *Groundwater recharge, *Recharge, *Water resources development, Climatic zones, Field tests, Geologic fractures, Groundwater management, Groundwater movement, Groundwater potential, Hydrologic models, Infiltration, Isotope studies, Model studies, Numerical analysis, Water resources management, Water yield.

Two projects have been developed in Burkina Faso, Africa, in order to evaluate by multidisciplinary methods the recharge of basement aquifers in sahelian and sudanese climates, and to perform realistic field tests of exploitation of large yields destined for the irrigation of small areas. The recharge study was carried out on ten pilot stations included within the scope of the first project. Monitoring over a two-year period provided the numerical information required for the constitution and the calibration of combined rain/water level models which allowed the quantitative analysis of the water transit from the surface to the water-saturated underground. Roughly 300 samples were collected for isotope analysis, to attempt dating the water and to study the movement of water masses within the fissured medium. A striking phenomenon of recharge was thus observed and characterized, in both climates concerned. It supposes the infiltration of between 50 and 150 mm of water for the different latitudes in which the tests were conducted. It was also observed that a partitioning effect of the drainage basins into sub-units occurs by water isotopes in particular, which is more and more marked towards the dry zones. This indicates that the aquifers to be exploited in the sahel zones will be even more fragile. (See also W91-03178) (Author's abstract)
W91-03182

HYDROGEOLOGICAL PARAMETER ESTIMATION TECHNIQUES: LOCAL TEST, MODEL FITTING, STOCHASTIC METHODS, AND THE USE OF TRACERS.
Paris-4 Univ. (France).
G. de Marsily, and P. Lachassagne.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 63-75, 49 ref.

Descriptors: *Aquifer testing, *Developing countries, *Geohydrology, *Hydrologic models, *Model studies, *Parametric hydrology, *Water resources development, Analytical methods, Aquifer characteristics, Geostatistics, Groundwater management, Groundwater movement, Groundwater potential, Permeability, Pumping tests, Slug tests, Tracers, Transmissivity, Water resources management.

For most hydrogeological problems the permeability, or transmissivity, of an aquifer is the most important parameter to be determined. To do so, the hydrologist can measure a variety of magnitudes in the field, but he can never directly measure a permeability: he has to rely on a model to interpret the measurements and calculate a permeability or transmissivity. A very large number of models is available, with varying underlying assumptions. It is useful to first define a local parameter value; it is clear then that such local values are frequently highly variable in natural media. One can then try to determine which type of average of these local values is estimated by each method, and what type of average is needed for solving the problem at hand. Geostatistics can be of great help to estimate averages as well as local values at any scale of interest. It is important to apply geostatistics to the correct variable. A slug test or injection test over a small section of a well or piezometer should be considered as the basic method to determine aquifer properties in the field; such tests should then be performed at numerous locations to determine both the type of distribution and the variogram of the local permeability values. In low-permeability media, however, such tests should be continuous, then used to estimate the local transmissivity at the well or the regional transmissivity in the area. Long-term pump tests should be considered as a means to validate the averages which could be obtained from the local measurements. The use of environmental tracers may be helpful as analogs for contaminant transport. (See also W91-03178) (Fish-PTT)
W91-03183

STOCHASTIC SPATIAL PREDICTION OF HYDROGEOLOGIC PARAMETERS: ROLE OF CROSS-VALIDATION IN KRIGINGS.
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 7C.
W91-03184

GROUNDWATER FLOW IN UNSATURATED/SATURATED ZONES.
Colorado State Univ., Fort Collins.
H. J. Morel-Seytoux, and C. Miracapillo.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 91-106, 7 fig, 1 tab, 11 ref.

Descriptors: *Aeration zone, *Groundwater movement, *Infiltration, *Model studies, *Surface-groundwater relations, *Water resources development, Analytical methods, Developing countries, Flow models, Groundwater management, Groundwater recharge, Hydrologic models, Parametric hydrology, Recharge basins, Unconfined aquifers, Wadi, Water resources management.

The unsaturated zone plays a crucial role in the hydrologic cycle as the link between surface and groundwater. Though there are many aspects to this interaction, examination of a single aspect, that of aquifer recharge, will illustrate nevertheless most essential elements in the linkage. Typically intermittent streams (wadis) and (artificial) infiltration basins are not in permanent hydraulic connection with the underlying water table aquifer. As water becomes available in the wadi or in the basin, infiltration proceeds. Due to the frequent presence of a clogged layer the water flow below the wadi (or basin) bed is unsaturated. Recharge occurs only after the unsaturated wetting front

reaches the water table. On the other hand, long after infiltration has ceased at the soil surface, recharge continues from the unsaturated storage in excess of field capacity, which has accumulated above the water table during the infiltration phase. The three-dimensional character of the flow is rendered by a technique that consists of matching a flow solution in a vertical cross-section with a flow pattern in a horizontal plane. Practical examples illustrate the influence of the parameters on the water table level below the infiltrating area and on the lateral recharge rate into the part of the aquifer which is not overlain by the river or basin bed. Comparison with field observations shows the technique to be accurate, inexpensive, and easy to apply. (See also W91-03178) (Author's abstract)
W91-03185

ESTIMATING GROUNDWATER RECHARGE USING SURFACE AND SOIL WATER BALANCES.

Institute of Hydrology, Powys (Wales).
J. A. Hudson.

IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 107-137, 5 fig, 90 ref.

Descriptors: *Groundwater recharge, *Hydrologic models, *Model studies, *Recharge, *Surface-groundwater relations, Analytical methods, Great Britain, Groundwater management, Groundwater potential, Hydrologic data collections, Remote sensing, Water resources development, Water resources management.

Groundwater resources in Britain are divided between those in the chalk, limestone, and permotriassic sandstone aquifers of the south and east and the smaller, less continuous, yet locally important drift and gravel aquifers of the upland north and west. Assessment of the worth and sustainable yields of these sources has depended on the development of techniques for estimating the rate of renewal of groundwater by recharge; these methods rely heavily on the use of surface and soil water balances. The framework, if not necessarily the detail, of these methods is of equal relevance to problems of groundwater exploitation in the developing countries. The relative merits of the available physical, mathematical, and chemical techniques suggests that the main objective should be the provision of comprehensive data collection networks for monitoring precipitation, evaporation, soil moisture content and tension, transpiration, soil moisture drainage and streamflow, in order to construct spatially and temporally relevant models of groundwater recharge. Appropriate data is hard to find in developed countries, which generally have a dense hydrometric infrastructure in place, let alone in developing countries where large scale exploitation of resources is only just beginning. Even where reliable, accurate, precise, long-term records are available, the ability to construct physical models is constrained by the lack of information on the spatial variability of vegetation, soils, and groundwater stores. Remote sensing from airplanes and satellites might eventually solve some of the spatial problems, but the techniques are as yet in their infancy. (See also W91-03178) (Fish-PTT)
W91-03186

INTERACTION BETWEEN THE GROUNDWATER AND UNSATURATED SOIL-WATER FLOW REGIONS.

Rothamsted Experimental Station, Harpenden (England).
E. G. Youngs.

IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 139-154, 2 fig, 39 ref.

Descriptors: *Groundwater movement, *Infiltration, *Recharge, *Soil water, *Surface-groundwater relations, Aeration zone, Analytical methods, Darcys law, Groundwater management, Hydrologic models, Model studies, Physical models, Soil physical properties, Water resources development, Water resources management, Wetlands.

The application of the physics of water movement through soils provides a rational basis for the management and development of water resources. The physics of water movement in saturated and unsaturated soils is used as the basis of a rational approach to problems involving the interaction between the groundwater and unsaturated soil-water flow regions. Two applications were made using physical theory: (1) the effect of evaporation on water table levels in unconfined aquifers under artesian conditions was analyzed; and (2) the movement of water tables in low-lying wetlands as a response to meteorological input was computed. The classical theory used is based on continuum physics embodied in Darcy's law and Richards' equation for flow through inert homogeneous porous materials. However, the classical theory is inadequate in many real situations when there is soil heterogeneity, when there is soil swelling and shrinking, and when there is soil aggregation. To apply the classical theory of soil-water movement, these complications need to be considered when making measurements of soil properties for predicting water flow in soils; measurements of hydraulic soil properties have to sample volumes larger than the soil's representative elementary volume, which can be found only by repeated measurement on different-sized samples. The collection of good field data could remain a major problem in the understanding of the physics of water movement in both saturated and unsaturated soils. (See also W91-03178) (Fish-PTT)
W91-03187

GEOHYDROLOGICAL DATA ACQUISITION: SOME IMPERATIVES.

National Geophysical Research Inst., Hyderabad (India).
C. P. Gupta.

IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 155-164, 1 fig, 2 tab, 4 ref.

Descriptors: *Data acquisition, *Groundwater data, *Hydrologic data, *Network design, *Water resources development, Databases, Economic aspects, Geohydrology, Groundwater management, Management planning, Water resources management.

There has been a growing realization of the need for a reliable and credible database for an objective and rational management of groundwater resources. The need is felt all the more strongly in developing countries where the demand on groundwater resources has been incessantly mounting due to a fast growth of population and increased agricultural activities. The objective of a geohydrological data acquisition system (GDAS) is the generation of an appropriate database which could be transformed into a meaningful information system for a hazard-free development of groundwater resources. The design of a GDAS should take into account (1) essential features of the geohydrological regime, (2) specific needs of the users, an (3) the available financial resources for the establishment, operation, and management of the system. Standardization of the methodology and unrestricted accessibility to the database are other prerequisites for communication and meaningful utilization of the geohydrological data. (See also W91-03178) (Author's abstract)
W91-03188

GEOHYDROLOGICAL DATA BASE FOR WATER MANAGEMENT.

Jawaharlal Nehru Technological Univ., Hyderabad (India).
B. H. Briz-Kishore.

IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 165-174, 4 fig, 2 tab, 6 ref.

Descriptors: *Computer models, *Data storage and retrieval, *Databases, *Groundwater management, *Hydrologic data collections, *Water resources development, *Water resources management, Data processing, Data requirements, Developing countries, Economic aspects, Management planning, Social aspects.

Effective water management acts as a catalyst for extensive socioeconomic development and administrative policy modernization. The extent of modernization depends upon the stimulating impact of the data processing itself, and it is in this sense the geohydrological database development, as part of the water management process, becomes one of the most crucial building blocks of public administration. It is well-known that the data required for different applications in water management is copied from original field records several times. This kind of data-copying results in the redundant storage of data under the same processing environment. Conventional methods involving different physical file structures pose severe limitations such as rigidity for carrying out any extensions and necessity for frequent reorganization. Hence it is essential to formulate an efficient data storage and interaction mechanism removing all the prevailing lacunae and limitations of conventional methods of storage through recently-emerging database systems. A computerized database will provide integrated information on mass balance at any point of time for pragmatic planning, efficient execution, and serious monitoring of several socioeconomic schemes for the benefit of the society. The system can be operated even by nontechnical persons and is capable of responding to several queries simultaneously to stimulate the information through graphic outputs, when well-defined documentation is available. (See also W91-03178) (Author's abstract)
W91-03189

3-D STOCHASTIC DISCRETE FRACTURE NETWORK MODEL FOR SIMULATING FLOW AND TRANSPORT THROUGH FRACTURED MEDIA.

Ecole Nationale Superieure des Mines de Paris, Fontainebleau (France). Centre d'Information Geologique.
M. C. Cacas, E. Ledoux, G. de Marsily, and B. Tillie.

IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 175-197, 11 fig, 1 tab, 25 ref.

Descriptors: *Flow models, *Fracture permeability, *Geologic fractures, *Groundwater management, *Groundwater movement, *Hydrologic models, *Model studies, *Water resources management, Analytical methods, Channel flow, Flow rates, France, Hazardous waste disposal, Hydraulic conductivity, Hydrologic data, Stochastic models.

A large-scale investigation of fracture flow was recently conducted in a granite uranium mine at Fanay-Augeres, France. Its aim was to develop a methodology for the investigation of possible nuclear waste repository sites in crystalline environments, and thus to determine what measurements to make, and what models to use in order to predict the flow rate in the medium. Four types of data were collected: (1) geometry of the fracture network; (2) local hydraulic properties measured by injection tests in boreholes; (3) global hydraulic behavior from flow rate and piezometric head distribution; and (4) tracer tests. A stochastic fracture network model was developed. The fractures are represented by geometrical discs. The flow through the disc network is simulated by assuming that it occurs through small 'channels.' The model calibration consisted in adjusting the local channel hydraulic conductivities. The model was then used to predict the global hydraulic behavior. This attempt to validate the parameters and the model structure appeared to be positive. A particle trans-

port simulator was coupled to the flow model, based on a particle-following method using the advection-biased random-walk technique. Microscopic dispersion in the fractures and slowing-down effects due to unevenness of the flow paths were taken into account. The transport model was calibrated on tracer tests. The mode! appears to be able to account for the large-scale channeling phenomenon observed in situ. Moreover, its dispersive properties controlled by the network geometry and the hydraulic conductivities assigned to its flow elements are reasonably comparable to those of the real site. (See also W91-03178) (Author's abstract)
W91-03190

NEW APPROACH TO TRACER TRANSPORT ANALYSIS: FROM FRACTURE SYSTEMS TO STRONGLY HETEROGENEOUS POROUS MEDIA.
California Univ., Berkeley. Earth Sciences Div.
C. F. Tsang.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 199-222, 15 fig, 30 ref. DOE contract number DE-AC03-76SF00098.

Descriptors: *Fracture permeability, *Geologic fractures, *Hydrologic models, *Tracers, Flow models, Groundwater management, Groundwater movement, Groundwater transport, Model studies, Paths of pollutants, Permeability, Water resources development, Water resources management.

In the utilization and management of groundwater resources, a problem that has come into increasing attention in both developed and developing countries is the need for monitoring and maintaining groundwater quality. Many current developments and utilizations of groundwater resources include a study of their flow and transport properties. These properties are needed to evaluate possible changes in groundwater quality and potential transport of hazardous solutes through the groundwater system. Investigation of transport properties of fractured rocks is an active area of research. Most of the current approaches to the study of flow and transport in fractured rocks cannot be easily used for analysis of tracer transport field data. A new approach is proposed based on a detailed study of transport through a fracture of variable aperture, a two-dimensional strongly-heterogeneous permeable system. Tracer breakthrough curves can be analyzed based on an aperture or permeability probability distribution function that characterizes the tracer flow through the fracture. The results may be extended to a multi-fracture system and can be equally applied to a strongly-heterogeneous porous medium. The need for multi-point or line and areal tracer injection and observation tests is a way to avoid the sensitive dependence of point measurements on local permeability variability. (See also W91-03178) (Author's abstract)
W91-03191

NUMERICAL GROUNDWATER QUALITY MODELLING: THEORETICAL BASIS AND PRACTICAL APPLICATIONS.
Gesamthochschule Kassel (Germany, F.R.).
W. K. H. Kinzelbach.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 223-241, 8 fig, 28 ref.

Descriptors: *Flow models, *Groundwater movement, *Hydrologic models, *Model studies, *Path of pollutants, *Solute transport, Analytical methods, Aquifer characteristics, Dimensional analysis, Dispersion, Management planning, Stochastic models, Water resources development, Water resources management.

The types of problems requiring models of the transport of pollutants and their transformation in the saturated zone include: data interpretation; understanding of mechanisms of transport and reactions; estimation of pollutant degradation rates and concentrations; identification of major pollutant sources; and various management planning alternatives. The basis for any model is the mass balance equation in its differential form. Three levels of solving the transport equation can be distinguished: analytical solutions, pathline solutions, and full numerical solutions. Any real world problem is spatially three-dimensional and time-dependent. Yet, approximations in lower spatial dimensionality (i.e. zero-dimensional models, one-dimensional models, horizontally two-dimensional models, and vertically two-dimensional models) are often feasible. The modeling of macrodispersion in the non-asymptotic stage is as yet an unsolved and maybe unsolvable problem. The use of Fickian dispersion models with constant dispersivities is a crude tool only in which the dispersivities are mere fitting parameters. Stochastic techniques are still in the developing phase and more field validations are called for before they can be used on a routine basis in practical aquifer contamination problems. Modeling of chemical processes in aquifer materials remains inherently a complicated task, since the possible number of reaction processes and participating constituents are large. The modeling of flow and transport requires a large amount of data. Usually only a few of these are readily available; some must be estimated by means of a properly-calibrated model. (See also W91-03178) (Fish-PTT)
W91-03192

GROUNDWATER CONTAMINATION: PROCESSES, CHARACTERIZATION, ANALYSIS, AND REMEDIATION.
GeoTrans, Inc., Herndon, VA.
For primary bibliographic entry see Field 5G.
W91-03194

COUPLED MODELLING OF WATER CYCLE AND NITRATE TRANSPORT IN A HYDROLOGICAL SYSTEM.
For primary bibliographic entry see Field 5B.
W91-03195

ARTIFICIAL RECHARGE OF GROUND WATER: STATE OF ART AND LIMITATIONS.
Central Ground Water Board, Ahmedabad (India).
For primary bibliographic entry see Field 4B.
W91-03196

SYSTEMS FOR ARTIFICIAL RECHARGE OF GROUND WATER.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 4B.
W91-03197

APPROPRIATE METHODOLOGIES FOR DEVELOPMENT AND MANAGEMENT OF GROUNDWATER RESOURCES IN DEVELOPING COUNTRIES.
Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. 541p. Edited by C. P. Gupta.

Descriptors: *Developing countries, *Groundwater management, *Groundwater resources, *Water resources development, *Water resources management, Aquifers, Geologic fractures, Groundwater pollution, India, Model studies, Workshops.

Groundwater resources increasingly are being tapped to meet societal needs. However, it is important to recognize that, although groundwater has ubiquitous occurrence and vast magnitude, its potential as a perennial source is subject to wide spatial and temporal variations. It is renewable, but not inexhaustible and, although it is underground, it is not entirely protected from pollution. This second volume of the proceedings of Workshop IGW-89 considers state-of-the-art techniques for geohydrological parameter estimation, data acquisition, analysis of flow in unsaturated zones, studies of contaminant migration, and augmentation of groundwater. Appropriateness of the techniques for use in developing countries is emphasized in many presentations. Specific sessions covered in volume 2 are: management of groundwater resources, particularly in hard rocks (parameterization of groundwater flow regime, modeling of complex aquifers, simulation of flow in fractured rocks, and assessment of dynamic potential of aquifers); pollution of aquifers (groundwater quality modeling, modeling of migration of non-reactive/reactive chemicals, radioactive nuclear waste, and remedial measures); and augmentation of water resources (artificial recharge, rainwater harvesting, and constraints and limitations). (See W91-03312 thru W91-03365) (Rochester-PTT)
W91-03311

OVERVIEW OF FLOW SIMULATION MODELS IN FRACTURED AQUIFERS.
Indian Inst. of Science, Bangalore.
K. Sridharan, M. S. Mohan Kumar, and M. Sekhar.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 485-498, 6 fig, 17 ref.

Descriptors: *Aquifers, *Geologic fractures, *Groundwater movement, *Mathematical models, *Model studies, *Simulation, Groundwater pollution, Indian Institute of Science, Path of pollutants, Reviews, Solute transport.

Mathematical models of groundwater resources have been applied successfully in various situations, but controversy remains concerning the applicability of porous media flow concepts in hard rock aquifers. The obvious differences between hard rock formations and the simple grains-pores picture, as well as the presence of mechanical discontinuity, have raised basic questions. Groundwater flow simulation models for fractured rock aquifers are reviewed here under four categories: (1) fracture-based models; (2) equivalent porous medium models; (3) double porosity models; and (4) leaky aquifer models. The fracture-based models require detailed field data, which can be obtained only on a large scale. Hence these models may be more suited to oil well applications and studies of hazardous contaminant transport, such as nuclear waste. The double porosity models may be more relevant for groundwater applications., particularly well hydraulics. The leaky aquifer model with an aquifer-water table-aquitard system has conceptual similarity with the double porosity model. A general two-domain model that allows lateral and vertical flow in the water table domain, flow transfer between the domains, and considers the effects of anisotropy, well storage, and partial penetration may represent groundwater flow in a fractured rock system. Such a model has the advantage that it can be applied for dug wells or bore wells and, with some simplifications, can be used for regional applications. Numerical solutions have been obtained recently at the Indian Institute of Science for models incorporating some additional simplifications of this general two-layer system. (See also W91-03311) (Rochester-PTT)
W91-03312

NONDEFEATIST DERIVATION OF FINITE DIFFERENCE SCHEMES.
Roorkee Univ. (India). Dept. of Earth Sciences.
P. S. Moharir.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 499-504, 8 ref.

Descriptors: *Finite difference methods, *Groundwater movement, *Mathematical models, *Model studies, Differential equations, Mathematical equations, Performance evaluation.

Groundwater modeling requires solving a partial differential equation subject to initial and boundary conditions. In finite difference modeling, first the derivations are replaced by suitable finite difference approximations, and then the resultant numerical scheme is tested for stability. Although it seems natural to try to improve the approximation in the first stage, it is well established that a more accurate finite difference approximation for the derivatives does not imply automatically a stabler finite difference scheme. The two-stage procedure therefore must be regarded as defeatist, because under it the outcome of the second stage is seen as inevitable and when the result is unfavorable the scheme is abandoned. A nondefeatist approach recommends that the twin objectives of stability of the finite difference scheme and the accurate approximation of the net differential operator be dealt with simultaneously. Both explicit and implicit examples are offered. Besides being a pedagogically preferable method for derivation of finite difference schemes, the method has other advantages. The method explicitly shows compromises that must be made in the condition of unbiasedness, proper diffusivity, and good convergence. Also, the method is very general. (See also W91-03311) (Rochester-PTT)
W91-03313

HYDROGEOLOGY OF THE MIDDLE CHELIFF BASIN (ALGERIA): SIMULATION OF GROUNDWATER FLOWS.
Neuchatel Univ. (Switzerland). Center of Hydrology.
M. Bouzelboudjen, and J. Mania.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 505-521, 8 fig, 2 tab, 11 ref.

Descriptors: *Algeria, *Geohydrology, *Groundwater movement, *Model studies, Aquifers, Cheliff River, Developing countries, Hydrologic models, Mathematical models, Middle Cheliff Basin, Simulation, Surface-groundwater relations, Water demand, Water resources development.

The hydrologic analysis of the alluvial plain of the Middle Cheliff basin (Algeria) permits the successive definition of the boundaries of the alluvial reservoir and the associated sandstone formations, the aquifer geometry, and the hydrologic budget. It appears that the aquifer deposits are thick (100-180 m) on the right bank of the Cheliff River, with the presence of sedimentary deposition gaps (Pliocene-Miocene) in the meridional part of the basin. The utility of the mathematical model based on the finite element method, with steady state conditions, can justify the working hypothesis, with an improvement of the knowledge of hydraulic characteristics of the aquifer and the calculation of complete hydrologic balance. It shows that the effective precipitation and the surface waters of the Cheliff stream represent 40% and 22% of the inputs, respectively. A second simulation based on the finite difference method, with unsteady conditions, leads to the evaluation of the values of specific yield and the determination of the impact of irrigation on the piezometric evolution of the water table. The total requirement of 37 cu hm for the year 2000, with 16.6 cu hm for potable water, 18.4 cu hm for agricultural water, and 2 cu hm for industrial water, cannot be satisfied by pumping only from the aquifer. (See also W91-03311) (Author's abstract)
W91-03314

ROLE OF VERTICAL FLOW IN SEDIMENTARY AQUIFERS.
Birmingham Univ. (England). Dept. of Civil Engineering.
K. R. Rushton, and M. Thangarajan.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 523-538, 8 fig, 7 ref.

Descriptors: *Aquifers, *Geohydrology, *Groundwater mining, *Groundwater movement, *India, *Pumping, *Vertical flow, Hydrologic models, Model studies, Sedimentary basins, Water demand.

In attempting to understand the responses of sedimentary aquifers to pumping, it is essential to recognize that vertical as well as horizontal flows can occur. Three case studies in India of deep aquifers, from which substantial quantities of water are being abstracted, demonstrate the methods of identifying the presence of both horizontal and vertical flows. Methods of quantifying the vertical flows are introduced. The three aquifers in which vertical flows can be demonstrated are Mehsana, Madras, and Neyveli. Five indicators of vertical flows have been recognized: (1) overflowing wells and springs or high piezometric heads occurring prior to the exploitation of the aquifer; (2) falling piezometric heads and reduction in flow in perennial rivers; (3) increasing pumped drawdowns due to increasing abstraction; (4) continuing long-term fall in the water table elevation; and (5) evidence of vertical flows derived from tracer studies. Vertical flows can be quantified by three different methods: using Darcy's law, examination of a typical cross section, and use of numerical models. In each of the three aquifers considered here, it was originally assumed that groundwater originated from an up-dip recharge area. In the undisturbed state, this was a valid assumption about the conditions within the aquifer. However, heavy exploitation of the aquifers meant that the horizontal flows from the recharge zones no longer were sufficient to meet the demands and vertical flows became important. (See also W91-03311) (Rochester-PTT)
W91-03315

ESTIMATING GEOHYDROLOGIC PARAMETERS FOR GROUNDWATER MANAGEMENT AND LAND SUBSIDENCE CONTROL IN KANTO PLAIN, JAPAN.
National Geophysical Research Inst., Hyderabad (India).
N. Shibasaki.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 539-544, 3 fig, 4 ref.

Descriptors: *Geohydrology, *Groundwater management, *Japan, *Model studies, *Subsidence, Finite element method, Hydrologic budget, Kanto Plain, Mathematical models, Optimization, Pumping tests, Simulation, Statistics.

Kanto Plain, central Japan, is one of the largest plains in Japan; it has been urbanized since the 1950s. Detailed geohydrological investigations were carried out in the Kanto Plain for basin-wide groundwater management and to evolve appropriate strategies for prevention of land subsidence. Geological and hydrogeological studies/analyses were carried out to construct computer simulation models. Geohydrologic parameters were estimated by statistical analyses using pumping tests/routine production tests of water wells and soil test data. The calculated groundwater level and land subsidence obtained with the vertical two-dimensional, multi-aquifer model using the finite element method agreed satisfactorily with the observed values. The water balance and land subsidence studies, which were based on accurate geological and hydrogeological studies/analyses, have helped greatly in evolving optimal exploitation schemes for this area. (See also W91-03311) (Author's abstract)
W91-03316

OPTIMAL PUMPING POLICY AND GROUNDWATER BALANCE FOR THE BLUE LAKE AQUIFER INVOLVING NON-LINEAR GROUNDWATER HYDRAULICS.
Indian Inst. of Tech., Bombay. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4B.
W91-03317

DETERMINATION OF ANISOTROPIC PERMEABILITY OF AN UNCONFINED AQUIFER IN EGYPT USING PUMPING TEST DATA OF A PARTIALLY PENETRATING WELL.
International Inst. for Hydraulic and Environmental Engineering, Delft (Netherlands).
For primary bibliographic entry see Field 7B.
W91-03318

GROUNDWATER BASIN SIMULATION OF MAHI RIGHT BANK CANAL COMMAND AREA, GUJARAT, INDIA.
Punjab Agricultural Univ., Ludhiana (India). Dept. of Soil and Water Engineering.
S. K. Sondhi.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 581-593, 3 fig, 4 tab, 11 ref.

Descriptors: *Groundwater recharge, *India, *Model studies, *Pumping, *Simulation, *Water level fluctuations, *Water table, Groundwater potential, Hydrologic models, Mahi Right Bank Canal Command Area, Mathematical models, Prediction, Statistics, Water resources development.

A groundwater basin simulation model was used to predict the dynamic behavior of the water table in response to groundwater pumpage and net recharge in part of the Mahi Right Bank Canal (MRBC) command area, Gujurat, India. The model is based on a finite difference approach and uses an iterative alternating direction implicit technique as the solution procedure. The model was calibrated and validated by using historical input data. Some statistical parameters such as the mean, standard deviation, coefficient of correlation, and a non-parametric statistical test were used to study the extent of agreement between the observed and the predicted water table depths. No significant difference was found between the distribution of the observed and the predicted water table depths at the 95% confidence level. Net recharge to the groundwater basin was calculated and used for determining additional groundwater potential. The additional groundwater potential available for development in the area is about 265 million cubic meters, which is about 1.6 times the existing level of groundwater development. Sufficient scope exists for a substantial increase in groundwater development. (See also W91-03311) (Author's abstract)
W91-03319

NUMERICAL SIMULATION OF GROUNDWATER FLOW IN FUHRBERG FIELD, HANOVER.
National Geophysical Research Inst., Hyderabad (India).
S. N. Rai, and B. Hoffmann.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 595-606, 6 fig, 1 tab, 6 ref.

Descriptors: *Germany, *Groundwater movement, *Model studies, *Numerical analysis, *Simulation, *Water table fluctuations, Hydrologic budget, Mathematical models, Prediction, Spatial distribution, Temporal distribution, Water level fluctuations.

Groundwater is the main source of water supply to Hanover City (Germany); much of it is obtained from Fuhrberg field. A mathematical model was employed to simulate dynamic behavior of the water table in response to recharge, pumpage, and interaction with a river in Fuhrberg field. An area of 372 sq km, with a maximum extension of 26 km (E-W) by 18 km (N-S) was considered in the

analysis. Water balance analysis was conducted for a period of 14 yr and the model was used to predict the spatio-temporal distribution of the water table in response to proposed pumping and artificial recharge schemes. Based on use of the model, the following conclusions were drawn: (1) good agreement exists between computed and measured water table heights, confirming the validity of the model for simulation in this study area; (2) groundwater flow during the period of investigation (April 1968 through April 1982) exhibited a state of balance; and (3) prediction results indicate an increase in aquifer storage, which leads to a rise in the water table. (See also W91-03311) (Rochester-PTT)
W91-03320

SIMULATION OF REGIONAL HYDRODYNAMICS IN THE NEYVELI AQUIFER.
National Geophysical Research Inst., Hyderabad (India).
C. P. Gupta, M. Thangarajan, V. V. S. Gurunadha Rao, N. K. Balasundar, and S. Muthuram.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 607-618, 10 fig.

Descriptors: *Aquifers, *Groundwater movement, *India, *Mining effects, *Model studies, Geohydrology, Hydrodynamics, Hydrologic models, Leaky aquifers, Lignite, Mathematical models, Neyveli aquifer, Regional analysis, Simulation, Surface-groundwater relations.

The groundwater flow regime in the Neyveli basin (Tamilnadu, India) has been perturbed due to groundwater withdrawals from lignite mines and a large number irrigation wells in the area. The available geohydrological data were analyzed thoroughly for the conceptualization of the complex aquifer system. Both two-dimensional and three-dimensional mathematical models were constructed and aquifer modeling was used to obtain a first-order quantitative understanding of the vertical flows and aquifer-river interactions in the basin. The leakage from the phreatic aquifer into the groundwater regime below the lignite seam contributes significantly toward controlling the hydrodynamics of the region. The model studies also helped in the design of field experiments for better quantification of spatio-temporal variations of geohydrological parameters. (See also W91-03311) (Author's abstract)
W91-03321

COMPARATIVE MODEL STUDY FOR GROUNDWATER RESOURCES EVALUATION IN KELANTAN, MALAYSIA: PART 1. MODEL EVALUATION.
National Univ. of Malaysia, Bangi.
S. Awadalla, I. M. Noor, and I. Ibrahim.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 619-627, 8 fig, 6 ref.

Descriptors: *Groundwater management, *Groundwater resources, *Hydrologic models, *Malaysia, *Model studies, *Water resources development, Aquifers, Developing countries, Observation wells, Piezometric head.

The increasing demand for water supply in Kelantan state, Malaysia, has created an increased need for evaluation, development, and management of groundwater resources. On the basis of recent hydrological investigations and available data on groundwater exploitation in Kelantan, a two-dimensional numerical groundwater model was developed to simulate the present situation and the possible future development of groundwater resources in the area. An optimum set of input data and parameters covering an 11-yr period were used to obtain simulated head values. A good agreement was obtained between these values and observed heads where the differences are quite minor. However, at certain nodes or areas of the aquifer, the computed values had distinct differences from the values measured in the field. Since the grid size for a particular node is quite large (5 km), the representation of the aquifer conditions at the observation wells is restricted. The average parameters and data represented may not be accurate enough to predict the heads at the wells. Nevertheless, the computed values compared quite well with the observed heads and the trends over time are similar. (See also W91-03311) (Rochester-PTT)
W91-03322

MODELLING THE EFFECTS OF PROPOSED PUMPING FROM THE TAMBRAPARNI RIVER BASIN, TAMILNADU, INDIA.
V.O.C. Coll., Tuticorin (India). Dept. of Geology.
A. Balasubramanian, and J. C. V. Sastri.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 629-640, 1 fig, 4 ref, 5 map.

Descriptors: *Groundwater mining, *Groundwater movement, *India, *Model studies, *Water resources development, Computer models, Groundwater resources, Hydrologic models, Mathematical models, Semiarid lands, Surface-groundwater relations, Tambraparni River, Water demand.

The Tambraparni River basin lies in the arid to semiarid climatic zone of India and receives an average annual rainfall of 88 cm. Groundwater occurs mainly under unconfined conditions in the weathered and fractured zones of the crystalline formations. The Tambraparni River is perennial at the present time. A two-dimensional, finite difference computer model was developed to model the groundwater flow of the Tambraparni River basin and was used as a predictive tool. Groundwater potentials were forecast under (1) normal, existing conditions and (2) with a limited stress of 1% increase in the amount of extraction per year up to 1991. The zones of depletion due to the proposed stress and the ultimate effects on groundwater exploitation schemes were inferred. Unwarranted mining of groundwater changes the entire effluent river system into an influent one by 1991. Based on the model results, it is concluded that overexploitation of any groundwater resource should be stopped. (See also W91-03311) (Author's abstract)
W91-03323

EXPLORATION AND DEVELOPMENT OF GROUNDWATER IN THE CRYSTALLINE ROCKS.
Tribhuvan Univ., Kathmandu (Nepal). Central Dept. of Geology.
G. Krishna Rao.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 641-648, 11 ref, 2 plate.

Descriptors: *Geohydrology, *Geologic fractures, *Groundwater potential, *Groundwater resources, *India, Crystalline rocks, Developing countries, Mineralogy.

Crystalline rocks, which constitute a major part of peninsular India, account for nearly 40% of the total aquifer extent in the country. Further irrigation potential of the country depends on understanding these complex aquifers. Field observations in different parts of Andhra Pradesh and Karnataka states revealed that the behavior of different rock types, felsic to mafic, in response to tectonics and weathering differs. Fracture intensity is highest in quartz veins, followed by granites and granitic gneisses and related rocks. Mafic rocks generally are massive with sporadic fracturing. Similarly, the weathered residue from the felsic rocks is relatively more permeable than that from the mafic rocks. The quartz content in crystalline rocks plays a vital role in making them potential aquifers. The weathered residue of quartz-rich felsic rocks would be relatively more permeable than the quartz-poor mafic or basic rocks. Similarly, quartz veins or quartzites and felsic rocks are more brittle than the mafic rocks and hence develop more fracture intensity. In this area, groundwater exploration and development is recommended for the quartz veins and felsic rocks rather than in mafelsic and mafic rocks. (See also W91-03311) (Rochester-PTT)
W91-03324

MANAGEMENT OF GROUND WATER RESOURCES IN COMPLEX AQUIFER SYSTEM OF RAJMAHAL TRAPS OF SAHEBGANJ DISTRICT, BIHAR.
For primary bibliographic entry see Field 4B.
W91-03325

GROUNDWATER ASSESSMENT IN THE SEDIMENTARY BASINS OF EASTERN KENYA.
Nairobi Univ. (Kenya).
G. O. Krhoda.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 661-668, 4 tab, 11 ref.

Descriptors: *Arid lands, *Drought, *Geohydrology, *Groundwater mining, *Groundwater potential, *Groundwater resources, *Kenya, Comparison studies, Data acquisition, Developing countries, Geophysical methods, Lithologic logs, Sand rivers, Stratigraphy, Tana River, Well logs.

Groundwater resources of the sedimentary basins of eastern Kenya were assessed. The sediments were laid down between Paleozoic and Quaternary periods. The area is generally drought-stricken and comprises nearly two-thirds of the total area of the country. The mean rainfall decreases while the rate of potential evapotranspiration increases going northward and eastward. Aridity of the area results from high temperature combined with lack of vegetative cover. The region is drained by sand rivers, except for the Tana River, which runs along the southern boundary. Several geophysical methods were employed with differing success rates. Because of the remoteness of the area, well logging was the most useful method for reconstructing the stratigraphy. Preliminary investigation on the nature of lithologic logs shows that three types of geological terranes within the sedimentary basins of the area have potable water. The first is Pliocene and Quaternary deposits comprising the unconsolidated or poorly consolidated sand and gravel, commonly interbedded with clay. The second terrane consists of semi-consolidated and consolidated agglomerate, sandstone, or shale formations, which are often joined and possess intergranular and fracture porosity and permeability. The third geologic terrane comprises limestone and gypsum beds, which generally contain saline water, largely calcium sulfate. Further research is needed to demarcate these and other geologic terranes in the country. (See also W91-03311) (Author's abstract)
W91-03326

GONDWANA ARTESIAN BASIN IN WEST GODAVARI DISTRICT, ANDHRA PRADESH, INDIA.
B. J. Kumar, K. V. S. Sastry, and K. V. R. J. Krupanidhi.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 669-672, 2 fig.

Descriptors: *Artesian basins, *Geohydrology, *Groundwater mining, *Groundwater potential,

*Groundwater resources, *India, Aquifers, Conjunctive use, Irrigation water, Potentiometric surface, Water resources development, Wells, West Godavari District.

The Central Ground Water Board (CGWB) of India carried out groundwater exploration during the period 1967 to 1972 in the Gondwana basin and identified potential aquifers down to a depth of 300 m. With increased irrigation demand, the CGWB extended its activity to the adjacent areas to explore the possibility of locating deeper Gondwana aquifer systems underlying the younger formations. During the period 1977 to 1984, exploration was carried out down to a depth of 600 m, proving the existence of deeper potential aquifers in Gondwana formations of this district. The Deccan traps form an ideal confining layer for the underlying Gondwana formations, resulting in free-flowing conditions for wells tapping deeper Gondwana aquifers. Granular zones exist from 100 to 260 m down to the explored depth (600 m). The yields from these granular zones range from 3700 to 6000 lpm for varying drawdowns of 19 to 25 m. The average permeability of these granular zones is 10 m/day. The elevation of the potentiometric surface of these aquifers varies from 4 to 25.5 m above ground level, with a gradient of 1 in 200 towards the southeast. These deeper, high-potential aquifers extending from Eluru to Tadepalligudem can be tapped by a battery of heavy-duty tubewells. The free-flowing area between Muppavaram and Kaikaram, near the end of the Eluru canal, can be taken up for conjunctive use of surface and ground waters. Groundwater potential of 83 million cu m is estimated to occur in this area and it can be exploited by constructing 150 tubewells. (See also W91-03311) (Rochester-PTT)
W91-03327

GROUNDWATER DEVELOPMENT FOR DROUGHT RELIEF IN CHANDRAPUR DISTRICT, MAHARASHTRA.
Central Ground Water Board, Nagpur (India).
M. Sankaran, S. Marwah, T. Talukdar, M. R. K. Reddy, and A. K. Madhukar.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 673-676, 1 fig.

Descriptors: *Drought, *Geohydrology, *Groundwater resources, *India, *Water resources development, Chandrapur District, Developing countries, Domestic water, Rural areas, Water supply development, Well logs.

Well logging was conducted in Maharashtra state, India, in response to the drought of 1987-1988. Existing well data were analyzed in relation to rock structure, and sites were selected for wells in the district. In this district, the groundwater resource is the only major source meeting the needs of all water supply schemes in the rural areas. Based on the available data and with proper planning, the program of construction of tubewells in the Gondwana formations has proceeded well. Out of 27 sites selected in the Gondwana formations, 26 tubewells were constructed successfully. Construction of tubewells in Talchir formations, which had not been attempted previously in this district, proved successful in providing domestic water supply. Out of 121 sites selected in Chandrapur district, 51 sites were selected for construction of borewells in the hard rock area. Borewells have been drilled at 24 sites. At Devai, one borehole was abandoned and three borewells were dry at the time of construction. Future groundwater studies should help to meet the needs for village water supplies free from pollution and contamination. (See also W91-03311) (Rochester-PTT)
W91-03328

ADVANCING FRONTIERS OF LATHI-BARMER FRESH WATER MESOZOIC FORMATIONS OF BARMER DISTRICT.
National Environmental Engineering Research Inst., Nagpur (India).
P. G. Adyalkar.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 677-680, 6 ref.

Descriptors: *Aquifers, *Geohydrology, *Groundwater resources, *India, Barmer district, Confined groundwater, Developing countries, Perched groundwater, Remote sensing, Sandstones, Satellite technology, Water table.

In the Mesozoic super group identified in the Barmer district (India), there are two characteristic groups of fresh water bearing formations: Lathi sandstone of Jurassic age and the Cretaceous Barmer sandstone. Recent studies by satellite imagery have defined better the extent of these formations. As a result of intensive work carried out in the period 1952-1964 and subsequently, the Lathi-Barmer formations have been recognized as the most dependable formations in the district. Groundwater occurs in them under perched, phreatic, and confined conditions, the last varying in depth, aggregate thickness, and coarseness of the formation. The phreatic surface ranges from 27 to 75 m below ground level, whereas the piezometric surface ranges from 32 to 92 m. The discharges obtained from boreholes tapping 18-40 m thickness of granular zones range from 6 to 20 L per sec for a drawdown range of 2-15 m. While the specific capacity ranges from 25 to 750 L/min/m of drawdown, the transmissivity ranges from 90 to 1170 sq m/day and hydraulic conductivity from 5 to 32 m/day. (See also W91-03311) (Rochester-PTT)
W91-03329

INDRAVATI-KOLAB BASINS OF KORAPUT AS POTENTIAL GROUND WATER RESERVOIRS OF THE PURANAS IN ORISSA.
National Environmental Engineering Research Inst., Nagpur (India).
P. G. Adyalkar.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 681-684, 6 ref.

Descriptors: *Geohydrology, *Groundwater potential, *Groundwater reservoirs, *Groundwater resources, *India, Developing countries, Drawdown, Geologic fractures, Groundwater basins, Groundwater movement, Hydraulic conductivity, Indravati-Kolab basins, Koraput District, Limestone, Specific yield, Well yield.

The Indravati-Kolab (Sabari) basins of Koraput district in Orissa (India) continue with the identical basins of the same name downgradient in Bastar district of the Chhattisgarh region of Madhya Pradesh. The sandstones, quartzites, and conglomerates of the Purana sequence are poor and problematic aquifers with occasional networks of four or more joints, including a master joint. Such networks of joints extend in depth to 30-60 m. The Kanger calcic limestone is flaggy, but the Jagdalpur magnesian stromatolitic limestone is heterogeneous, resulting in classic development of karst in the Indravati-Kolab basins of Koraput district. With average rainfall in the range of 170-190 cm, wells in the micro-alluvial valleys and karst often are limited to 12 m in depth. Individual tubewells, 90 m deep, are capable of yielding 5-8 L/sec for a drawdown of 6 m, the piezometric zone being 4.5-15 m below ground level. The specific capacity ranges from 50 to 150 L/min/m of drawdown and yield potential is 150-300 cu m/day for a drawdown of 5-10 m, when developed under strict hydrogeologic control. The hydraulic conductivity ranges from 5-10 m/day and the specific yield is 3-8%, with a spacing pattern of 250 m. Laterites, although of limited extent, are of great significance from the point of view of the occurrence of seeps and springs in the highland areas and the richness of the groundwater potential. (See also W91-03311) (Rochester-PTT)
W91-03330

GROUNDWATER MANAGEMENT PLANNING OF ALAPAKKAM AREA, TAMILNADU, INDIA.
Sri Venkateswara Univ., Tirupati (India).
For primary bibliographic entry see Field 4B.
W91-03331

GROUND WATER FLOW IN SOUTHERN PART OF KOSI ALLUVIAL FAN AND ITS EFFECT ON WATERLOGGING, WITH POSSIBLE REMEDIAL MEASURES, DISTRICT SAHARSA, BIHAR, INDIA.
Central Ground Water Board, Patna (India).
P. N. Singh.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 689-697, 3 fig, 1 tab, 2 ref.

Descriptors: *Alluvial aquifers, *Groundwater movement, *India, *Waterlogging, Alluvial fans, Flood control, Kosi River, Kosi District, Water table rise.

Groundwater flow along the ground slope and waterlogging are common in the Kosi district alluvial fan area (India). The shallow depth to water table with phreatic conditions within the sandy aquifer indicate a groundwater surplus. A water table map was prepared based on field studies with the aim of explaining the cause of waterlogging. Water from seepages forms the headwaters of a new stream or accumulates in low-lying areas leading to waterlogging. The continuous groundwater flow is maintained by the influent condition of the Kosi River in its upper reaches. Depth to water table data for 7 yr does not indicate any appreciable rise or difference in water level, even during years of scanty rainfall, and no marked difference in water level has been noticed. The only rise of depth to water table has been recorded in the area along an unlined canal, which is one of the major causes of waterlogging in the area. Among the measures considered for dealing with the waterlogging problem are construction of fish ponds to decant the groundwater from the adjoining land, thus lowering the water table and removal of silt from the river to both lower the water table and improve flood control. (See also W91-03311) (Author's abstract)
W91-03332

SELECTING EFFECTIVE METHODS FOR GROUNDWATER PROSPECTING AND EXPLORATION IN MEKONG DELTA.
General Department of Mine and Geology, S. R. Vietnam.
B. X. Pham.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 701-708.

Descriptors: *Data acquisition, *Geohydrology, *Groundwater mining, *Groundwater potential, *Vietnam, *Water resources development, Aquifers, Developing countries, Field tests, Geophysical surveys, Hau River, Mekong River, Saline groundwater.

In the Mekong delta (Vietnam), groundwater for domestic and industrial uses could be exploited from young sedimentary formations of Cenozoic age. Hydrogeologically these sedimentary formations are very complex and exhibit an irregular distribution of hydrochemical zones. The fresh water-bearing layers are inter-related with saline ones, especially in the region lying between the Tien (Mekong) River and Hau (Bassac) River. Using well drilling and pump test projects for groundwater prospecting as in the past is very expensive and at times has not fully satisfied the

technical requirements. Among new approaches, geophysical methods are being used exclusively for studying fluctuations in level and to determine saline-fresh water boundaries. Since 1980, dozens of regions in the Mekong delta, with average areas of 400-600 sq km, have been explored, with the drilling of hundreds of boreholes with a total length of nearly 100,000 m. Analysis of research needs for this area shows several points: (1) two research stages, prospecting and exploration, are more appropriate than the presently employed three stages (prospecting, preliminary exploration, and detailed exploration); (2) only simple lines of boreholes are employed during the prospecting stage in order to determine the boundaries of the fresh water-bearing formations; (3) increase the application of geophysical methods; (4) thoroughly exploit existing observational data on surface water and groundwater movements as a way of calculating the regime of the various aquifers; (5) apply hydrogeochemical methods more effectively to determine groundwater quality; and (6) employ aerial photography to determine the region's general structure and the smaller structures, with the aim of forecasting groundwater distribution according to area and depth. (See also W91-03311) (Rochester-PTT)
W91-03333

IMPACT OF INTENSIVE IRRIGATION ON GROUNDWATER REGIMEN IN PARTS OF OSMANSAGAR AREA, R. R. DISTRICT, A. P., INDIA.
Osmania Univ., Hyderabad (India). Dept. of Geology.
For primary bibliographic entry see Field 5G.
W91-03334

GROUNDWATER QUALITY OF AN ALLUVIAL AQUIFER.
Centre for Water Resources, Madras (India).
For primary bibliographic entry see Field 5B.
W91-03335

DROUGHTS AS MEANS OF DELINEATION OF AREAS PRONE TO SEA WATER INTRUSION.
National Geophysical Research Inst., Hyderabad (India).
B. S. Sukhija, D. V. Reddy, and I. V. Reddy.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 733-741, 4 fig, 1 tab, 4 ref.

Descriptors: *Drawdown, *Drought, *Groundwater movement, *India, *Saline water intrusion, Groundwater mining, Hydraulic gradient, Pondicherry, Potentiometric surface.

Over-exploitation of groundwater along the coast may result in declining water levels accompanied by the reversal of hydraulic gradient. Work was undertaken in Pondicherry (India) and its surrounding areas with the aim of demonstrating that the comparative study of groundwater levels, groundwater flow, and gradients of normal rainfall, drought, and excessive rainfall could be used to delineate areas prone to sea water encroachment. Drought affects water level in two ways: (1) by reducing recharge and (2) extending the period of agricultural use for irrigation, thus further dropping the mean groundwater level. Using 1979 as the base year, it is shown that groundwater withdrawal increased substantially (to 1.5 times input) during the period 1980-1981 and 1982-1983, resulting in an average decline in groundwater levels of 7 m in the study area. The changes in the shape of the potentiometric surface over this period resulted in reversals of groundwater flow direction from uniformly toward the Bay of Bengal to landward in a few areas, creating areas prone to sea water intrusion. (See also W91-03311) (Rochester-PTT)
W91-03336

GEOCHEMISTRY OF SHALLOW GROUNDWATER AT KIGAMBONI PENINSULA ALONG DAR ES SALAAM COASTAL STRIP TANZANIA.
Dar es Salaam Univ. (Tanzania). Dept. of Geography.
H. H. Nkotagu.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 743-753, 3 fig, 2 tab, 10 ref.

Descriptors: *Geochemistry, *Groundwater chemistry, *Groundwater quality, *Tanzania, *Water quality, Classification, Coastal areas, Dar Es Salaam, Indian Ocean, Potable water, Public health, Sulfates.

Groundwaters near Dar Es Salaam (Tanzania) were sampled and chemically classified. Water types identified were sodium bicarbonate, sodium sulfate, sodium chloride, calcium bicarbonate, and magnesium bicarbonate. Hydrochemical facies change from calcium-sodium facies near the shore of the Indian Ocean to sodium-calcium facies landward and from chloride-sulfate-bicarbonate to bicarbonate-chloride-sulfate. Dissolution of dolomitic limestone, cation exchange, and mixing of fresh recharge water with interstitial marine water, in addition to dissolution of airborne salts, are the major processes responsible for the chemical character of the water. Using the World Health Organization and United States Geological Survey diagrams, water quality was assessed and recommended as suitable for domestic and irrigation uses. In one area, sulfate exceeds the limits of the WHO guidelines. (See also W91-03311) (Rochester-PTT)
W91-03337

DIGITAL MODELLING OF THE HYDROGEOCHEMICAL FACIES OF GROUNDWATERS IN TAMILNADU, INDIA.
V.O.C. Coll., Tuticorin (India). Dept. of Geology.
A. Balasubramanian, R. Thirugnana Sambandam, R. Chellasamy, and J. C. V. Sastri.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 761-767, 1 fig, 13 ref, 1 map.

Descriptors: *Geochemistry, *Geohydrology, *Groundwater chemistry, *India, *Mathematical models, *Model studies, *Water chemistry, Calcium, Carbonates, Cations, Chlorides, Classification, Dissolved solids, Electrical conductivity, Hydrogen ion concentration, Multiple regression analysis, Principal component analysis, Sulfates, Tamilnadu.

Identification, classification, and interpretation of hydrogeochemical facies normally are attempted through graphical representation. Developmental planning of groundwater resources requires a complete picture/model of the major ion characteristics. Factor, principal components, and multiple regression analyses were adopted to develop deterministic and predictive hydrochemical models for the groundwaters of Tamilnadu (India). The deterministic model could show the principal chemical components of aquifers, their pattern of distribution, and the residence time of groundwaters in aquifers. Results of the predictive model could reduce the cost of chemical analysis of sequential water samples normally conducted in a groundwater system. Studies were conducted in two river basins, the Tambraparni and the Vaigai. For the Tambraparni, the dominant factors were: (1) Cl, electrical conductivity (EC), Ca, and total dissolved solids (TDS), with 61.03% of the variance; (2) CO3, pH, SO4, and Na + K, with 75.47% of the variance, and (3) HCO3, Na + K, and TDS, with 85.06% of the variance. For the Vaigai, the principal components were: (1) Cl, Mg, and Na + K, with 52.50% of the variance, (2) SO4, HCO3, and Mg, with 72.75% of the variance, and (3) HCO3 and Na + K, with 87.69% of the variance. Hydrochemical models developed from these results could be used to determine the chemical characteristics of groundwater at any location of interest. Multiple regression analysis could be used as a positive predictive tool for determining the chemistry of the groundwater if the dependent variable EC is measured at any location. (See also W91-03311) (Rochester-PTT)
W91-03339

ANALYSIS OF BREAKTHROUGH CURVES FOR ASSESSING MOVEMENT OF CONTAMINANTS.
Central Soil Salinity Research Inst., Karnal (India).
For primary bibliographic entry see Field 5B.
W91-03340

DISPERSION OF POLLUTANTS IN POROUS MEDIA FLOW ONE-DIMENSIONAL APPROACH.
College of Engineering, Poona (India).
For primary bibliographic entry see Field 5B.
W91-03341

NUMERICAL MODELLING OF MASS TRANSPORT EQUATION.
Banaras Hindu Univ., Varanasi (India). Dept. of Geophysics.
For primary bibliographic entry see Field 5B.
W91-03342

SINGLE-PHASE/TWO-PHASES NUMERICAL MODEL USING NESTED SQUARE MESHES.
Ecole Nationale Superieure des Mines de Paris, Fontainebleau (France). Centre d'Information Geologique.
E. Ledoux, S. Sauvagnac, and A. Rivera.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 803-814, 9 fig, 13 ref.

Descriptors: *Groundwater movement, *Mathematical models, *Model studies, *Numerical analysis, *Path of pollutants, *Saline water intrusion, *Saline-freshwater interfaces, Coastal aquifers, Nested square meshes, Regional analysis.

A numerical model (NEWVAR) to simulate both the regional groundwater flow and the transient movement of a discrete interface between freshwater and saline-water or any other fluid has been developed. NEWVAR is designed to allow the analysis of a regional two-dimensional groundwater flow in coastal aquifers and permits the prediction of regional freshwater level (one-phase) and two-dimensional freshwater/saline water interface location (two-phases) using nested square meshes. The numerical solution is based on the finite difference method. After an optimal renumbering search, the Gauss-Jordan direct method or the Gauss-Siedel iterative method, through a predictor-corrector scheme, are used for solving steady-state, non-linear equations in the two-phase mode, successively for the freshwater and saline-water terms. In transient state the system of equations is simultaneously solved through semi-implicit method. Different original procedures are used to avoid difficulties generally found in such two-phase models with respect to tracking the transient position of the interface toe. The use of nested square meshes allows both a fine resolution in certain areas along with the possibility of reaching distant hydrogeological boundaries using a minimum of meshes. The numerical solution was tested against analytical ones for the cases of an advancing-retreating interface and a floating freshwater lens over saline water. These tests showed good agreement, thus verifying the finite difference approximation and the original procedures used to overlay the toe tracking dilemma. (See also W91-03311) (Author's abstract)
W91-03343

MEASURES TO OVERCOME THE SALINITY PROBLEMS OF THE COASTAL AREAS IN GUJURAT.

Gujarat Water Resources Dept., Gandhinagar (India).
For primary bibliographic entry see Field 4B.
W91-03345

HYDROCHEMICAL CLASSIFICATION OF THE GROUNDWATER OF THE WADI AL BIH WELLFIELD IN THE NORTHERN PART OF THE UNITED ARAB EMIRATES.
United Arab Emirates Univ., Al Ain. Dept. of Geology
For primary bibliographic entry see Field 2K.
W91-03347

SEMI-ANALYTIC SOLUTION OF ONE-DIMENSIONAL DISPERSION CONVECTION EQUATION.
Punjab Agricultural Univ., Ludhiana (India). Dept. of Soil and Water Engineering.
For primary bibliographic entry see Field 5B.
W91-03348

STUDY OF GROUNDWATER POLLUTION AT TIRUMALA, TIRUPATI, INDIA.
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 5B.
W91-03350

CASE STUDY OF INTEGRATED EXPLORATION PRACTICE FOR SHALLOW FRESH WATER AQUIFERS IN SOUTHERN PARTS OF RAMNAD DISTRICT (TECHNOLOGY MISSION PROJECT).
AFPRO GIT Unit III, Coimbatore.
J. Srinath, R. Mohommed, and K. M. Namboodiri.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 899-902, 6 fig.

Descriptors: *Aquifers, *Geophysical exploration, *Groundwater mining, *Groundwater resources, *India, Freshwater, Geophysical methods, Paleochannels, Potable water, Ramnad District, Remote sensing, Rural areas, Saline water, Vertical electrical sounding, Water supply development.

The subsurface water in the Mudukulathur block of Ramanathapuram district (Tamil Nadu, India) is mostly saline and at some places it is saltier than sea water. Pits and shallow wells dug out in the tank beds support the need for drinking water in the summer and the quality of water can change daily. A 100-sq km area was selected under the CAPART Technology Mission Project, with the aim of conducting detailed surface water and groundwater studies. Remote sensing, electrical soundings, and pH studies provided information that allowed the area to be classified into four regions for detailed field work. Vertical electrical sounding (VES) profiles were developed and shown to coincide with local geological conditions as determined by remote sensing. Hydradrill equipment was used to drill test holes, and based on the results, production wells were constructed at Kumarakkurichi, Sivalinga puram, Rajakkalpalayam, and Thothamangalamwadi to depths of 10.6, 10.8, 13.8, and 4.9 m, respectively. The four wells were fitted with India Mark II hand pumps and are yielding potable water. This study demonstrated that with remote sensing and water quality data measurements, VES traverses can be used to locate fresh water pockets. The technique was also useful in tracing paleochannels. The fresh water pocket is limited, even in the terri sand area, although it is elevated to 30 m above sea level. In such an environment, pumping schemes may have to be abandoned. (See also W91-03311) (Rochester-PTT)
W91-03351

HYDROGEOCHEMICAL MODELING.
Kerala Univ., Trivandrum (India). Dept. of Geology.
V. Narayanan Nair.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 903-906, 16 ref.

Descriptors: *Geochemistry, *Groundwater chemistry, *Groundwater pollution, *Hydrogeochemical models, *Mathematical models, *Model studies, *Water chemistry, Computer programs, Kinetics, Literature review, Thermodynamics.

Hydrogeochemical modeling is important because of the socioeconomic importance of groundwater and the need to prevent its contamination with pollutants. A hydrogeochemical model is the integration of mathematical, thermodynamic, and kinetic relationships on which the geochemical calculations are based. The required calculations are facilitated by modern electronic computers. The data base required consists of the results of chemical analysis of water samples and should include all the major cationic and anionic elements and the important trace elements. Three types of calculations typically are done: (1) speciation, (2) mass balance, and (3) mass transfer and reaction path. More than 50 computer programs for hydrogeochemical models have been prepared by workers in the field. These computer models have been developed for various purposes and no single code can be used for all applications. The results from computer models can be used to establish baseline geochemical conditions for potential nuclear waste repository sites in India and to simulate the geochemical behavior of transported radionuclides. (See also W91-03311) (Rochester-PTT)
W91-03352

SIWANA-BARMER FRESH WATER BOWLS AS A PANORAMA OF MICRO-ALLUVIAL VALLEYS IN RASASTHAN DESERT.
National Environmental Engineering Research Inst., Nagpur (India).
P. G. Adyalkar, and V. K. Bhagdikar.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 907-910, 8 ref.

Descriptors: *Alluvial aquifers, *Geohydrology, *Groundwater movement, *Groundwater reservoirs, *Hardness, *India, Dissolved solids, Groundwater resources, Well yield.

Micro-alluvial valleys are essentially tiny and individually minimally significant alluvial bodies strewn in the midst of the Malani group of rocks (India). Individually they rarely exceed 500 sq km and they are very limited in depth. In a recent study of Barmer district, two potential fresh water bowls were identified, one in the eastern sector covering the major part of Siwana tahsil and the other west of Barmer in an amphitheater region of Barmer tahsil. The discharge of tubewells in the Siwana bowl varies from 10 to 20 L/sec for a drawdown of 6-20 m, tapping 40-65 m of granular zones in a depth range of about 100m. The specific capacity varies from 35 to 200 L min/m of drawdown with matching high transmissivity and hydraulic conductivity. Dug wells in both the bowls are capable of yielding up to 100 cu m/day with variable phreatic surface. With an areal extent of about 2000 sq km, the static groundwater resources have been estimated at 2000 MCM, most of which remains to be tapped. The water quality in these regions is good, with total dissolved solids of 310-1080 mg/L, total hardness of 70-260 mg/L as CaCO3, chlorides of 50-220 mg/L, and sulfates of 40-120 mg/L. (See also W91-03311) (Rochester-PTT)
W91-03353

DISTRIBUTION OF FLUORIDE IN SHALLOW AQUIFERS IN AND AROUND DISTRICT ROHTAK, HARYANA STATE.
Panjab Univ., Chandigarh (India). Dept. of Geology.
For primary bibliographic entry see Field 2K.
W91-03354

NITRATE POLLUTION IN THE GROUNDWATER OF SANGAREDDY AREA, ANDHRA PRADESH, INDIA.
Osmania Univ., Hyderabad (India). Dept. of Geology.
For primary bibliographic entry see Field 5B.
W91-03355

UNDERGROUND STORAGE OF SURPLUS FLOOD WATERS IN GANGETIC PLAIN.
Tata Inst. of Fundamental Research, Bombay (India).
For primary bibliographic entry see Field 4B.
W91-03356

AUGMENTATION OF WATER RESOURCES IN CANAL COMMANDED AREA.
Roorkee Univ. (India). Water Resources Development Training Center.
For primary bibliographic entry see Field 4B.
W91-03357

EFFECT OF DRAINAGE CHANNEL ON EVOLUTION OF WATER TABLE DUE TO RECHARGE FROM TWO PARALLEL CANALS.
Irrigation Design Organization, Roorkee (India).
D. N. Bhargava, G. C. Mishra, and S. Chandra.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 945-957, 4 fig, 2 tab, 2 ref.

Descriptors: *Canal seepage, *Drainage effects, *Groundwater recharge, *Irrigation canals, *Seepage, *Surface-groundwater relations, *Water table rise, Aquifers, Hydraulic engineering, Recharge, Statistical methods.

When irrigation canals are constructed in a basin where a natural drainage system generally exists, part of the recharge due to seepage from the canals will leave the basin through the natural drainage system. If a drainage channel exists near the canals, the water table may rise over time to near the bed level of the drainage channel due to seepage from the canals. A canal-aquifer-drainage channel interaction problem was solved using a discrete kernel approach. The time of activation of a drainage channel running parallel to two continuously running ridge canals and the return flow entering the drainage channel at different times after the activation of the drainage channel were predicted. The time of activation depends on the aquifer parameters, seepage rate from the canals, distance of the drainage channel from the canals, and the elevation of the drainage channel. If a drainage channel is located nearer to the canals, it receives return flow at a higher rate. The water table between two continuously running canals takes the shape of a plateau and it is marginally affected by the presence of the drainage channel. The study led to the following conclusions: (1) a drain activates earlier for canals having larger width, other factors remaining the same; (2) if the spacing between parallel ridge canals is increased, the time for activation of a drain is delayed; (3) a drain activates at an earlier time if its distance from the parallel canals is decreased; and (4) with the presence of a drainage channel, the maximum water table height under the canal (of two parallel canals) that is closest to the drainage channel is marginally affected during a certain initial period. (See also W91-03311) (Rochester-PTT)
W91-03358

WATER CONSERVATION AND ARTIFICIAL RECHARGE TECHNIQUES IN HARD ROCK AREAS.
Central Ground Water Board, Bhopal (India).

For primary bibliographic entry see Field 4B.
W91-03359

ROLE OF DRIP IRRIGATION IN GROUNDWATER MANAGEMENT IN BASALTIC TERRAIN: A CASE STUDY OF SOLAPUR DIST.
D.B.F. Dayanand Coll. of Arts and Science, Sholapur (India).
For primary bibliographic entry see Field 3F.
W91-03360

POSSIBILITIES OF INDUCED RECHARGE AND DEVELOPMENT OF DEEPER AQUIFERS FOR AUGMENTING WATER SUPPLY TO AMBALA URBAN AREA, HARYANA STATE.
For primary bibliographic entry see Field 4B.
W91-03361

INDUCED RECHARGE BY PERCOLATION TANKS IN PARTS OF MAHARASHTRA.
For primary bibliographic entry see Field 4B.
W91-03362

ARTIFICIAL GROUND WATER RECHARGE IN DROUGHT PRONE AREAS.
Central Ground Water Board, Hyderabad (India).
For primary bibliographic entry see Field 4B.
W91-03363

HYDRAULIC FRACTURING TEST FOR GROUNDWATER SIMULATION IN A KARSTIC LIMESTONE AQUIFER, HATTINGEN/BADEN-WEURTTENBURG, WEST GERMANY.
Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
For primary bibliographic entry see Field 4B.
W91-03364

SIMULATION STUDY CONCERNING STIMULATION OF GROUNDWATER BORE WELLS BY HYDRAULIC FRACTURING.
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 4B.
W91-03365

RELATIONSHIP OF RADIUM AND RADON WITH GEOLOGICAL FORMATIONS.
Research Planning Inst., Inc., Columbia, SC.
For primary bibliographic entry see Field 5B.
W91-03372

RIVER RECHARGE.
Caswell, Eichler and Hill, Inc., West Topsham, VT.
For primary bibliographic entry see Field 4B.
W91-03390

PUMP TEST ANALYSIS OF LEAKY AQUIFER.
Roorkee Univ. (India). Dept. of Civil Engineering.
P. K. Swamee, and C. S. P. Ojha.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 5, p 645-655, September/October 1990. 4 fig, 2 tab, 8 ref.

Descriptors: *Aquifer characteristics, *Groundwater potential, *Numerical analysis, *Parametric hydrology, *Pumping tests, Confined aquifers, Graphical analysis, Leakage, Leaky aquifers, Storage coefficient, Transmissivity, Well function.

The quantitative evaluation of an aquifer depends on accurate determination of its parameters. The storage coefficient, transmissivity, and leakage factor are the useful parameters that assess the groundwater potential of a leaky aquifer. These parameters can be determined with the help of pump test data by using graphical as well as numerical methods. Graphical methods are not very reliable as these are subject to personal error of judgment. On the other hand, numerical methods void of such errors rely on evaluation of the well function either by numerical integration or through approximation valid for small values of the arguments. Due to lack of a full-range equation for the well function, an entire set of pump test data is rarely used in analysis. A high-accuracy expression for the well function for a leaky artesian aquifer valid for an entire range of arguments has been developed, evolving a methodology for determination of cutoff error. By using this approximation well function and minimizing the sum of a criterion function based on the concept of cutoff error, aquifer parameters can be determined. (Author's abstract)
W91-03423

INVESTIGATION OF NONPOINT SOURCE POLLUTION ASSOCIATED WITH KARST AQUIFER SYSTEMS.
Western Kentucky Univ., Bowling Green. Dept. of Health and Safety.
For primary bibliographic entry see Field 5B.
W91-03435

GROUNDWATER SEEPAGE INTO THE INDIAN RIVER LAGOON AT PORT ST. LUCIE.
Florida Inst. of Tech., Melbourne. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W91-03438

COMPLEMENTARY INVESTIGATIVE TECHNIQUES FOR SITE ASSESSMENT WITH LOW-LEVEL CONTAMINANTS.
Science Applications International Corp., Golden, CO. Environmental Remediation Div.
For primary bibliographic entry see Field 5G.
W91-03445

TEMPORAL VARIATIONS OF CHLORINATED SOLVENTS IN ABSTRACTION WELLS.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 5B.
W91-03450

HYDROGEOLOGY OF THE BRUNSWICK (PASSAIC) FORMATION AND IMPLICATIONS FOR GROUND WATER MONITORING PRACTICE.
Deutsche Veterinaermedizinische Gesellschaft e.V., Giessen (Germany, F.R.).
A. Michalski.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 4, p 134-143, Fall 1990. 4 fig, 1 tab, 29 ref.

Descriptors: *Aquifer characteristics, *Aquifer systems, *Geohydrology, *Groundwater movement, *Groundwater pollution, *Path of pollutants, *Water quality monitoring, Aquitards, Brunswick Formation, Geohydrologic units, Geologic fractures, Leaky aquifers, Monitoring wells, New Jersey, Shales.

Fractured shales of the Brunswick Formation provide a major aquifer in the most industrialized region of New Jersey. Numerous cases of groundwater contamination have been documented in this formation. However, the effectiveness of monitoring and remediation efforts is often hampered by the use of inappropriate concepts regarding groundwater flow controls in this complex aquifer system. One such concept presumes that near-vertical fractures parallel to the strike of beds provide principal passages for the flow and produce an anisotropic response to pumping stress. Field evidence confirms that the Brunswick Formation hosts a gently dipping, multi-unit, leaky aquifer system that consists of thin water-bearing units and thick intervening aquitards. The water-bearing units are associated with major bedding partings and/or intensely fractured seams. Layered heterogeneity of such a dipping multi-unit aquifer system produces an anisotropic flow pattern with preferential flow along the strike of beds. Within the weathered zone, the permeability of the water-bearing units can be greatly reduced. The commonly used hydrogeologic model of the Brunswick as a one-aquifer system, sometimes with vaguely defined 'shallow' and 'deep' zones, often leads to the development of inadvertent cross-flows within monitoring wells. If undetected, cross-flows may promote contaminant spread into deeper units and impair the quality of hydrogeologic data. Hydrogeologic characterization of the Brunswick shales at any given site should be aimed primarily at identification of the major water-bearing aquitard units. Recommended techniques for this characterization include fluid logging and other in-well tests. (Author's abstract)
W91-03451

DETERMINATION OF TRACE CONCENTRATIONS OF VOLATILE ORGANIC COMPOUNDS IN GROUND WATER USING CLOSED-LOOP STRIPPING, EDWARDS AQUIFER, TEXAS.
Geological Survey, Austin, TX.
For primary bibliographic entry see Field 5A.
W91-03465

CAN CONTAMINATED AQUIFERS AT SUPERFUND SITES BE REMEDIATED.
Oak Ridge National Lab., TN. Office of Risk Analysis.
For primary bibliographic entry see Field 5F.
W91-03508

ORIGIN OF SALINE SOILS AT BLACKSPRING RIDGE, ALBERTA, CANADA.
Alberta Research Council, Edmonton. Terrain Sciences Dept.
R. Stein, and F. W. Schwartz.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 99-131, September 1990. 19 fig, 1 tab, 26 ref.

Descriptors: *Alberta, *Canada, *Geochemistry, *Geohydrology, *Saline groundwater, *Saline soils, *Saline water, *Water chemistry, Air-earth interfaces, Bedrock, Blackspring Ridge, Evaporation, Groundwater movement, Sediments, Soil types.

Problems of soil salinity occur at Blackspring Ridge, Alberta in four different settings. The most seriously affected area is at the base of the ridge where salinity appears as severe salt crusting on the surface, salt-tolerant vegetation, and areas of poor or no crop production. Blackspring Ridge is a structural bedrock high that is underlain by Upper Cretaceous sediment of the Horseshoe Canyon Formation. Bedrock is overlain by fluvial, glacial, lacustrine, and aeolian sediment. Piezometric data indicate that groundwater is recharged on and along the upper flanks of Blackspring Ridge and discharges in southern parts of a lacustrine plain that surrounds the ridge. Hydraulic conductivity data, water-level fluctuations, stable isotopes, and hydrochemical data indicate that the fractured near-surface bedrock and overlying thin-drift sediment constitute a zone of active groundwater flow within which salts are generated and transported. Water discharging from this shallow system evaporates and forms saline areas at the base of the ridge. The most seriously affected areas on the lacustrine plain coincide with places where the water table is less than 1.5 m from the ground surface. A high water table occurs locally because of the changing topology of geologic units, and lows in the topographic surface that focus groundwater and surface water flows. Some proportion of the shallow groundwater salinized by evaporation is also transported down the flow system where it mixes with unevaporated water. Surface water, from snowmelt and precipitation events, dissolves salt that was deposited at the surface by evaporating groundwater and redistributes the salt to areas of lower elevation. (Author's abstract)
W91-03544

POND SEEPAGE IN TWO AND THREE DIMENSIONS.
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2E.
W91-03545

DEFINITION OF GROUNDWATER FLOW PATTERNS BY ENVIRONMENTAL TRACERS IN THE MULTIPLE AQUIFER SYSTEM OF SOUTHERN ARAVA VALLEY, ISRAEL.
Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
E. Rosenthal, E. Adar, A. S. Issar, and O. Batelaan.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 339-368, September 1990. 8 fig, 1 tab, 31 ref.

Descriptors: *Alluvial aquifers, *Environmental tracers, *Flow pattern, *Groundwater movement, *Groundwater recharge, *Model studies, *Recharge, *Tracers, Aquifer characteristics, Arava Valley, Infiltration, Israel, Stable isotopes, Statistical analysis, Storm seepage, Water chemistry.

A model was developed for identification and semi-quantitative evaluation of the different water bodies replenishing groundwater in the southern Arava Rift Valley. The potential sources of recharge into the alluvial aquifer of the valley were assessed by multivariate cluster analysis of environmental tracers such as dissolved ions and stable isotopes. This data was also used to determine the flow pattern to the valley, and within its alluvial aquifer, to the natural outlet of the Red Sea. Spatial variations in the chemical compositions of groundwater and their isotopic ratios are explained as the result of differential rates of replenishment of various water bodies flowing to the Arava. The alluvial aquifer of the southern Arava Valley is recharged by the following water bodies: (1) lateral subsurface flow caused by infiltration of water from flash floods occurring in the neighboring mountain massifs; (2) upward and lateral groundwater flow from sandstone and carbonate aquifers in the Negev and Edom mountains; and (3) leakage from deep-seated brine reservoirs. (Author's abstract)
W91-03556

SURVEY REPORT: STATE ACTIVITIES TO PROTECT GROUND WATER FROM PESTICIDES.
Virginia Univ., Charlottesville. Div. of Urban and Environmental Planning.
For primary bibliographic entry see Field 5G.
W91-03575

TYPES AND EFFECTS OF MICROBIAL CONTAMINATION OF GROUNDWATER.
Environmental Protection Agency, Research Triangle Park, NC. Office of Research and Development.
For primary bibliographic entry see Field 5B.
W91-03577

VULNERABILITY OF KARST AQUIFERS TO CHEMICAL CONTAMINATION.
Environmental Protection Agency, Washington, DC. Office of Health and Environmental Assessment.
For primary bibliographic entry see Field 5B.
W91-03578

CHROMIUM DISTRIBUTION AND TRANSPORT BENEATH A CONTAMINATED SITE.
Sandia National Labs., Albuquerque, NM.
For primary bibliographic entry see Field 5B.
W91-03579

ANALYSIS OF PORE PRESSURE BEHAVIOR OF A ROCKFILL DAM DURING RESERVOIR FILLING.
For primary bibliographic entry see Field 8B.
W91-03591

ROLE OF CROPPING SYSTEMS IN ENVIRONMENTAL QUALITY: GROUNDWATER NITROGEN.
Agricultural Research Service, Lincoln, NE.
For primary bibliographic entry see Field 3F.
W91-03643

BOREHOLE GEOPHYSICS APPLIED TO GROUND-WATER INVESTIGATIONS.
W. S. Keys.
National Water Well Association, Dublin, Ohio. 1989. 313p.

Descriptors: *Borehole geophysics, *Data acquisition, *Geohydrology, *Geophysics, *Groundwater data, *Instrumentation, *Logging (Recording), *Measuring instruments, Groundwater resources, Quantitative analysis, Well logs.

The manual was designed to provide hydrologists, geologists, and others who have the necessary training with the basic information needed to apply the most useful borehole geophysical logging techniques to the solution of problems in groundwater hydrology. Geophysical logs can provide information on the construction of wells and on the character of the rocks and fluids penetrated by those wells and on these factors with time. The response of well logs is caused by: petrophysical factors; the quality, temperature, and pressure of interstitial fluids; and groundwater flow. Qualitative and quantitative analysis of the analog records and computer analysis of digitized logs are used to derive geohydrologic information. This information can then be extrapolated vertically within a well and laterally to other wells using logs. The physical principles by which the mechanical and electronic components of a logging system measure properties of rocks, fluids and wells, and the principles of measurement need to be understood to correctly interpret geophysical logs. Planning the logging operation involves selecting the equipment and the logs most likely to provide the needed information. Information on well construction and geohydrology are needed to guide this selection. Quality control of logs is an important responsibility of both the equipment operator and log analyst and requires both calibration and well-site standardization of equipment. Logging techniques that are widely used in groundwater hydrology or that have significant potential for application to this field include: spontaneous potential, resistance, resistivity, gamma, gamma spectrometry, gamma-gamma, neutron, acoustic velocity, acoustic televiewer, caliper, and fluid temperature, conductivity, and flow. The following topics are discussed for each of these techniques: principles and instrumentation, calibration and standardization, volume of investigation, extraneous effects, and interpretation and applications. (Author's abstract)
W91-03653

INTRODUCTION TO MODELING OF TRANSPORT PHENOMENA IN POROUS MEDIA.
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
J. Bear, and Y. Bachmat.
Kluwer Academic Publishers, Boston, Massachusetts. 1990. 553p.

Descriptors: *Groundwater movement, *Model studies, *Path of pollutants, *Porous media, Mass transport, Mathematical models, Porosity, Solute transport.

Practicing engineers and scientists are offered a theoretical background for the modeling of transport phenomena in porous media, applied to specific engineering problems. In principle, mathematical models of problems can be stated and solved at the microscopic level, in terms of values of variables specified at points inside each of the phases, whether fluid or solid, that occupy a porous medium domain. The main objective of the book is to present a methodology for constructing mathematical models of transport problems in a porous medium domain on the basis of the continuum approach. The book is divided into two parts: Part A, consisting of three chapters, presents the general theory of modeling transport phenomena in a porous medium domain. The first chapter presents the continuum approach, defines microscopic and macroscopic levels of description, introduces the concept of spatial averaging and defines some macroscopic characteristics of porous media and their constituents. Chapter 2 continues to develop this approach by presenting a description of transport phenomena at the microscopic level, and by deriving averaging rules for transforming the microscopic level of description of any transport problem to a macroscopic one, in which all state variables and parameters are macroscopic quantities. The various laws that govern the macroscopic fluxes of extensive quantities in a porous medium domain, are also derived. Thermodynamic concepts and quantities are introduced whenever necessary. Finally, by adding macroscopic initial and boundary conditions, a complete mathematical statement, or mathematical model, for any transport problem at the macroscopic level of description is obtained. This is discussed in Chapter 3. In Part B, the general theory presented in Part A is applied to specific problems of transport of mass and volume of a phase, mass of a component and heat in single and multiphase fluid systems in a porous medium domain. The appropriate models are developed at the macroscopic level. (Lantz-PTT)
W91-03654

HYDROLOGY OF LIMESTONE TERRANES: ANNOTATED BIBLIOGRAPHY OF CARBONATE ROCKS, VOLUME THREE.
International Association of Hydrologists.
J. M. Tanner, and R. ShoreDavis.
Contribution to UNESCO IHP Project A.1.13. International Contributions to Hydrogeology, Volume 2, 1986. 341p. Series editor Philip E. LaMoreaux.

Descriptors: *Bibliographies, *Carbonate rocks, *Geohydrology, *Groundwater movement, *Hydrology, *Karst hydrology, *Limestone.

Methods used to investigate the hydrological regime in carbonate terrains includes a broad spectrum of techniques from the fields of geology, geohydrology, hydrology, physics, chemistry, mathematics, and other disciplines. Some of the methods are simple; others are highly sophisticated. This annotated bibliography consists of citations listed alphabetically by principal author and numerically by document number. The annotated citations are followed by secondary author, location, and subject indexes. The Subject Index is preceded by a key to level terms used. The Location Index is by country, and secondarily by individual state. Each index lists the pertinent citations by document number. The bibliography primarily represents citations for the past decade (1975 through 1985) from the following data sources: a computer controlled search of GEOREF and GEOARCHIVE which contain publications of AGI and the Bibliography of North American Geology; Canadiana; American Book Publishing Record; Library of Congress Subject Catalog; Books in Print and Paperbound Books in Print; Bibliographic Guide to Conference Publications; Index to Scientific and Technical Proceedings; and Libros en Venta. (Lantz-PTT)
W91-03656

STATE GROUNDWATER PROTECTION POLICIES: A LEGISLATOR'S GUIDE.
National Conference of State Legislatures, Denver, CO.
For primary bibliographic entry see Field 5G.
W91-03657

ECONOMIC IMPLICATIONS OF GROUNDWATER CONTAMINATION TO COMPANIES AND CITIES.
Freshwater Foundation, Navarre, MN.
For primary bibliographic entry see Field 5C.
W91-03660

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY.
Geological Survey, Charleston, WV. Water Resources Div.
For primary bibliographic entry see Field 2E.
W91-03663

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS

PROVINCE, MISSOURI, ARKANSAS, KANSAS AND OKLAHOMA--SPRINGFIELD PLATEAU AQUIFER.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-03665

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS PROVINCE, MISSOURI, ARKANSAS, KANSAS, AND OKLAHOMA--WESTERN INTERIOR PLAINS CONFINING SYSTEM.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-03666

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS PROVINCE, MISSOURI, ARKANSAS, KANSAS, AND OKLAHOMA--ST. FRANCOIS AQUIFER.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-03667

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS PROVINCE, MISSOURI, ARKANSAS, KANSAS, AND OKLAHOMA.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-03668

HYDROGEOLOGY OF THE GALLUP SANDSTONE IN THE SAN JUAN STRUCTURAL BASIN, NEW MEXICO, COLORADO, ARIZONA AND UTAH.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-03669

POTENTIAL FOR AQUIFER COMPACTION, LAND SUBSIDENCE, AND EARTH FISSURES IN AVRA VALLEY, PIMA AND PINAL COUNTIES, ARIZONA.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-03670

HYDROLOGIC CHARACTERISTICS OF SOILS IN THE HIGH PLAINS, NORTHERN GREAT PLAINS, AND CENTRAL TEXAS CARBONATES REGIONAL AQUIFER SYSTEMS.
Geological Survey, Lincoln, NE. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-03671

GEOHYDROLOGY OF A THIN WATER-TABLE AQUIFER ADJACENT TO LAKE MICHIGAN, NORTHWESTERN INDIANA.
Geological Survey, Indianapolis, IN.
L. R. Watson, and J. M. Fenelon.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 235-245, 2 fig, 1 tab, 11 ref.

Descriptors: *Aquifer characteristics, *Geohydrology, *Great Lakes, *Groundwater movement, Calumet aquifer, Drainage water, Flow discharge, Groundwater quality, Indiana, Lake Michigan, Surface-groundwater relations, Unconfined aquifers, Water level, Water quality control, Water resources management.

The Calumet aquifer underlies a highly industrialized region of northwestern Indiana that contains three steel plants, one large petrochemical refinery, and many smaller manufacturing facilities. This water-table aquifer is composed of fine to medium beach and dune sands less than 65 feet thick. The water table generally is less than 8 feet below land surface. The geohydrologic characteristics of the Calumet aquifer were defined so that a network of groundwater observation wells could be properly installed for a subsequent water quality study. Maps of the water table and aquifer geometry were prepared, aquifer/stream interactions were monitored, and cross-sectional and areal finite difference digital models were constructed. The water table has broad, low-gradient mounds that generally lie between the major surface water drains. Water level records show that aquifer/stream interactions are complex and are somewhat dependent on the stage of Lake Michigan. In a 70-square-mile modeled area, the aquifer discharges about 5 to 10 cu ft/s of water to the Grand Calumet River/Indiana Harbor Canal, which subsequently drains to Lake Michigan. Less than 5 cu ft/s of water discharges directly to Lake Michigan along 20 miles of shoreline. In addition, 20 to 25 cu ft/s of groundwater discharges to leaky sewer systems. (See also W91-03672) (Author's abstract)
W91-03698

WATER QUALITY IN A THIN WATER-TABLE AQUIFER ADJACENT TO LAKE MICHIGAN, WITHIN A HIGHLY INDUSTRIALIZED REGION OF INDIANA.
Geological Survey, Indianapolis, IN.
For primary bibliographic entry see Field 5B.
W91-03699

GROUNDWATER QUALITY: THE ROLE OF AGRICULTURAL POLITICS AND POLICY.
Iowa Univ., Iowa City. Dept. of Geography.
For primary bibliographic entry see Field 6E.
W91-03706

GROUND WATER POLICY OF USDA.
Department of Agriculture, Washington, DC.
For primary bibliographic entry see Field 6E.
W91-03707

RESISTIVITY-RECHARGE RELATIONSHIPS--FIELD STUDY.
Nebraska Univ., Lincoln. Dept. of Civil Engineering.
B. Curtis, and W. E. Kelly.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 39-53, October 1990. 10 fig, 6 tab, 22 ref.

Descriptors: *Field tests, *Geophysical surveys, *Recharge, *Resistivity, *Resistivity surveys, *Soil water, *Vadose zone, Boreholes, Electrical properties, Hydraulic conductivity, Nebraska, Parametric hydrology, Particle size, Permeability, Soil types, Sounding.

From sounding measurements, the variation of electrical resistivity with depth in the soil-vadose zone can be determined. Resistivities were defined for different unsaturated sediment types by interpreting soundings made at locations in Nebraska where borehole control was available. Unsaturated sediments were found to have characteristic resistivities, with resistivity increasing with the coarseness of the soil. The soil resistivity data was combined with estimates of hydraulic conductivity to demonstrate relationships between recharge potential and resistivity. Ideally, such relationships would be based on hydraulic conductivities measured on samples taken from boreholes used for parametric soundings or better still, full-scale tests. In lieu of such measurements, estimates based on locally derived relationships using visual descriptions of grain size data can be used. For the purposes of this study, the ability to designate a range of resistivities as representing highly permeable, moderately permeable, or slowly permeable for recharge is probably appropriate and generally would be satisfactory. (Fish-PTT)
W91-03739

SIMULATION OF SALTWATER INTRUSION IN THE NORTHERN GUAM LENS USING A MICROCOMPUTER.
Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
D. N. Contractor, and R. Srivastava.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 87-106, October 1990. 15 fig, 1 tab, 10 ref.

Descriptors: *Coastal aquifers, *Computer models, *Groundwater management, *Microcomputers, *Saline water intrusion, *Saline-freshwater interfaces, *Simulation analysis, Computer programs, Field testing, Finite element method, Groundwater level, Groundwater movement, Hydraulic conductivity, Numerical analysis, Observation wells, Water depth.

For efficient planning and proper management of a coastal aquifer, it is essential to predict the extent of seawater intrusion into the aquifer in response to variations in the components of the freshwater mass balance. Numerical models used to predict the location of the saltwater interface for a given set of hydrologic conditions are broadly classified into two types: diffused interface models and sharp interface models. A two-dimensional (areal) finite element model of saltwater intrusion was modified so that it can run on a microcomputer. The model assumes a sharp interface between freshwater and salt water and simulates the movement of both freshwater and salt water. Linear triangular elements are used to discretize the domain. A preprocessor is used to renumber the nodes of a given network to reduce the bandwidth of the matrix. The model was applied to the Northern Guam aquifer. The hydraulic conductivity in three regions of the aquifer was calibrated using the water level history for a few observation wells. Field measurements of the depth of the interface indicate that the sharp interface assumption is valid for most of the aquifer. Comparison of the depth of the measured 50% isochlor with the computed depth of the interface shows that the two are equal at most locations. In some cases, the computed depth is less than the measured depth which results in a conservative estimate of the interface depth. (Author's abstract)
W91-03742

TRACING THE ORIGIN OF NATURAL WATERS IN A GLACIAL TILL SLOPE DURING SNOWMELT.
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Land and Water Resources.
For primary bibliographic entry see Field 2C.
W91-03743

EVOLUTION OF THE CHEMICAL COMPOSITION OF WATER PASSING THROUGH THE UNSATURATED ZONE TO GROUND WATER AT AN EXPERIMENTAL SITE AT THE UNIVERSITY OF SAO PAULO, BRAZIL.
Sao Paulo Univ. (Brazil). Inst. de Geociencias.
M. Szikszay, A. A. Kimmelmann, R. Hypolito, R. M. Figueira, and R. H. Sameshima.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 175-190, October 1990. 7 fig, 4 tab, 14 ref.

Descriptors: *Aeration zone, *Brazil, *Geochemistry, *Groundwater chemistry, *Vadose zone, *Water chemistry, *Weathering, Anions, Chemical properties, Climatic effects, Geology, Hydraulic conductivity, Infiltration, Lithology, Percolation, Soil water, Subtropic zone.

To study the evolution of the chemical composition of water infiltrating through the unsaturated zone to groundwater, water samples were collected weekly over a 14-month period, from porous cups installed at depth intervals of 50 cm through 12 m of the unsaturated zone, at an experimental site at the University of Sao Paulo, Brazil. Previous studies furnished precipitation, hydraulic conductivity, zero-flux plane, lithologic, and geologic data (mean) at the site. The analyses of chemical composition showed that at a depth of 0.5 m, the proportion of cations was exactly the same as that found in the rainwater, i.e., $rCa > rMg > rNa > rK$, where r = reacting value or meq/L. During percolation of water through the unsaturated zone, the proportion changed to $rNa > rK > rMg > rCa$, in the groundwater at the site, to $rNa > rCa > rK > Mg$, and finally at a well further downs-

lope to rCa > rNa > rK > rMg. The proportion of anions in the rainwater was rSO4 > rNO3 > rCl. Immediately after rainfall infiltration, this changed to rSO4 > rCl > rNO3 > rHCO3 in the soil with the appearance of HCO3(-), which became predominant in the groundwater, i.e., rHCO3 > rCl > rSO4 > rNO3. Thus the chemical composition of water in the upper part of the unsaturated zone at the experimental site is influenced by the climate whereas that in the lower part is affected more by local lithology. Three-dimensional computer treatment of each variable showed important variations in the chemistry of water with depth in the unsaturated zone. The variations are less pronounced over time, given the more-or-less uniform conditions of a subtropical climate throughout the year. (Author's abstract)
W91-03747

OVERFLOW THERMAL SPRINGS OF TUSCANY (ITALY).
Consiglio Nazionale delle Ricerche, Pisa (Italy). Ist. Internazionale per le Ricerche Geotermiche.
R. Celati, S. Grassi, and C. Calore.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 191-207, October 1990. 16 fig, 1 tab, 20 ref.

Descriptors: *Aquifers, *Flow models, *Geothermal water, *Groundwater movement, *Italy, *Model studies, *Thermal springs, Confined aquifers, Flow discharge, Flow pattern, Geothermal resources, Infiltration, Mathematical analysis, Outcrops, Permeability, Porous media, Spring water, Water circulation.

There are several low temperature geothermal systems spread over a large part of Tuscany, the Italian region containing high temperature geothermal fields. This region is characterized by a main thermal aquifer that is generally confined, except in some areas where the aquifer formations outcrop; most of the thermal springs of the region are located on the boundaries of these permeable outcrops. Field observations suggest a diffuse flow conceptual model for these springs as opposed to the commonly accepted models that assume water flow along faults or other isolated channels. Mathematical models assuming porous medium flow have been used to investigate some of the main characteristics of water circulation in such systems. The spring discharge can be supplied entirely by water absorbed into the adjacent permeable outcrops or by water belonging to the regional circulation, or by a mixture of the two in different proportions. Infiltration rate, surface morphology, and the resistance to water flow in the aquifer away from the permeable outcrops are factors strongly affecting the flow pattern and spring characteristics. (Author's abstract)
W91-03748

DRAWDOWN AROUND A WELL IN A HETEROGENEOUS, LEAKY AQUIFER SYSTEM.
Kuwait Inst. for Scientific Research, Safat.
F. Szekely.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 247-256, October 1990. 4 tab, 11 ref.

Descriptors: *Aquifer systems, *Aquifer testing, *Groundwater movement, *Leaky aquifers, *Model studies, *Numerical analysis, *Well hydraulics, Aquitards, Boundary conditions, Drawdown, Error analysis, Heterogeneity, Hydraulic properties, Piezometric head.

Real, leaky multiaquifer systems are composed of several aquifers separated by aquitards. All layers have nonuniform hydraulic parameters and irregular lateral extension following natural boundaries. Wells were replaced by point sources, and storativity of aquitards was neglected. A proposed synthesized analytical-numerical (SAN) method is based on the analytical multiaquifer well flow solution, used to treat the singularity of drawdown near the well, assuming laterally homogeneous hydraulic parameters and approximate boundary conditions. The second component of the total drawdown characterizes the effect of heterogeneity of hydraulic parameters and irregular barrier boundaries via distributed sources, and may be estimated by well-conditioned numerical methods. Numerical tests prepared for a well tapping the deepest aquifer of a five-aquifer system, show high numerical accuracy (1-10 mm) far from the well and along the well casing and screen. This numerical error corresponds to the accuracy of measurements of piezometric head and in this way enables one to apply this method for parameter calibration, path line, and travel time analysis in heterogeneous aquifer systems even in the vicinity of the wells. Owing to this feature of the solution, there is no need for extreme refinement of the computational mesh near wells or well fields; in locating nodes, only spatial heterogeneity and boundary conditions should be considered. Because of the linearity of governing equations, the described single well and/or single tapped aquifer solution may be extended easily to the most general case for a well field and/or several tapped aquifers, applying the well-known method of superimposition. (Fish-PTT)
W91-03751

ESTIMATION OF THE HYDRAULIC PARAMETERS OF THE RIO-MAIOR AQUIFER IN PORTUGAL BY USING STOCHASTIC INVERSE MODELING.
California Univ., Berkeley. Dept. of Civil Engineering.
Y. Rubin, J. P. LoboFerreira, J. D. Rodrigues, and G. Dagan.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 257-279, October 1990. 13 fig, 1 tab, 17 ref.

Descriptors: *Aquifer characteristics, *Flow equations, *Groundwater movement, *Model studies, *Portugal, *Stochastic models, Error analysis, Groundwater recharge, Hydraulic properties, Mapping, Mathematical models, Piezometric head, Rio Maior Aquifer, Transmissivity.

A preliminary study of a section of the Rio-Maior aquifer in Portugal was performed to identify the transmissivity and head regional distributions and the natural recharge as a function of time. A small number of transmissivity measurements on one hand and a relative abundance of head measurements (taken over a long period of time) on the other led to the casting of the identification problem in the framework of stochastic inverse modeling. The basic assumptions of the approach, are that the log-transmissivity Y is a normal and stationary random space function, the aquifer is unbounded, and a first-order approximation of the flow equation is adopted. The expected value of the piezometric head H as well as the Y unconditional autocovariance function have analytical expressions which depend on a parameter vector, all of which must be identified based on the model and by use of maximum likelihood procedures and subsequently computing the statistical moments of Y and H conditioned on the same data. This model was applied to the Rio-Maior aquifer, starting with data screening and identification of outliers among measurements, and finally drawing regional maps of the conditional Y and H with their error of estimation. Evaluation of the transmissivity distribution obtained by this method showed an improvement when compared with transmissivity distribution obtained without using the head measurements. (Author's abstract)
W91-03752

TRANSPORT IN HETEROGENEOUS POROUS FORMATIONS: 1. TIME-DEPENDENT CONVECTIVE DISPERSION.
Centre National de la Recherche Scientifique, Toulouse (France). Inst. de Mecanique des Fluides.
For primary bibliographic entry see Field 7C.
W91-03755

TRANSPORT IN HETEROGENEOUS POROUS FORMATIONS: 2. TIME-DEPENDENT DOUBLE DISPERSION.
Centre National de la Recherche Scientifique, Toulouse (France). Inst. de Mecanique des Fluides.
For primary bibliographic entry see Field 7C.
W91-03756

SENSITIVITY ANALYSIS OF '2D-FED,' A MODEL FOR SEAWATER ENCROACHMENT IN LEAKY COASTAL AQUIFERS.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W91-03757

PALAEOHYDROGEOLOGY OF THE SENEGAL SEDIMENTARY BASIN: A TENTATIVE EXPLANATION OF THE PIEZOMETRIC DEPRESSIONS.
Ecole Inter-Etats d'Ingenieurs de l'Equipement Rural, Ouagadougou (Burkina Faso).
B. Dieng, E. Ledoux, and G. de Marsily.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 357-371, October 1990. 6 fig, 11 ref.

Descriptors: *Africa, *Aquifer characteristics, *Arid-zone hydrology, *Depression head, *Evapotranspiration, *Geohydrology, *Paleohydrology, *Piezometric head, *Sedimentary basins, Evaporation, Numerical analysis, Sea level, Simulation analysis, Unconfined aquifers.

The superficial aquifers of the Senegal sedimentary basin, like many other coastal and internal basins in Africa, have piezometric anomalies characterized by a large cone of depression, but without any significant artificial withdrawal in the area. Such depressions are often referred to as 'hollow aquifers,' and may be explained by sea level variations on the Atlantic coast of Africa, following the last glaciation. This possibility was investigated with respect to the cause of the Ferlo piezometric depression of the Senegal sedimentary basin. A multilayered digital model of the entire hydrogeologic system was used to integrate the superficial phreatic aquifer and the underlying aquifers. Simulations were begun from 18,000 BP, thus covering the period from the maximum aridity and lowest sea level to the present. The hydrodynamic behavior of the aquifers was reconstructed, particularly the present piezometry of the entire three-layer system, which is compatible with that observed today, including the depressed shape of the central zone of Ferlo. It was shown that the apparent stable conditions observed today are in fact transient conditions, but with a rate of change too small to be noticeable on a human time scale. Other causes of transient conditions in aquifers can be tectonic uplift or collapse, withdrawal of confining load such as a glacier. However, evaporation losses from deep water table aquifers cannot be ruled out in some circumstances to explain some depressed head zones in truly steady state, as in those in Central Africa. In arid zones, it appears that evapotranspiration can extract water down to several meters in the upper soil and create a discharge from the aquifer by seepage upwards in the unsaturated zone. (Fish-PTT)
W91-03758

CL-36 IN GROUND WATER OF THE MAZOWSZE BASIN (POLAND).
Polish Academy of Sciences, Warsaw. Geological Sciences Inst.
For primary bibliographic entry see Field 2K.
W91-03759

HYDROGEOLOGICAL PROPERTIES OF THE MATRIX OF THE CHALK IN THE LUBLIN COAL BASIN (SOUTHEAST POLAND).
Academy of Mining and Metallurgy, Krakow (Poland). Inst. of Hydrogeology and Engineering Geology.
S. Borczak, J. Motyka, and A. Pulido-Bosch.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 5, p 523-534, October 1990. 11 fig, 18 ref.

Descriptors: *Areal hydrogeology, *Chalk, *Geohydrology, *Poland, *Soil water, Groundwater movement, Interstitial water, Mathematical analysis, Porosity, Soil porosity, Soil properties.

The geohydrological properties of the chalk matrix were determined from laboratory studies of the cores from five boreholes and two mineshafts sunk in a sector 30 km to the east of Lublin. The

interconnected values ranged from 0.15-0.50. More than half of the samples fell between 0.25 and 0.35, the most frequent value being 0.40 in a normal distribution pattern. The interconnected porosity parameter showed a clear tendency to diminish with depth in mineshaft. The average compressed air permeability values fell within the range 0.012-50.6 mDarcy. Conversion to their water equivalent, expressed in m/s (without applying Klinkenberg's correction), yields the following extreme results: 0.898 picometer/s and 0.388 micrometer/s. The values for this parameter adjust to a fairly homogeneous lognormal distribution. There does not seem to be any tendency for this parameter to vary with depth. The specific yield is very low; only 57 samples (slightly more than 37%) were capable of yielding water under the experimental conditions, with values ranging from 0.0001 to 0.0065. The gravitational water content therefore accounts for a very slight fraction of the chalk porosity. The Lublin coal basin matrix is a very porous but only slightly permeable porous medium; its water reserves are hardly susceptible to gravity drainage. The interconnected porosity of the chalk matrix diminishes with depth, probably because of the increase in lithostatic pressure. (Hoskin-PTT)
W91-03843

COMPARISON OF MODELS PREDICTING GROUND WATER LEVELS ON HILLSIDE SLOPES.
Stevens Inst. of Tech., Hoboken, NJ. Dept. of Civil, Environmental and Coastal Engineering.
L. N. Reddi, I. M. Lee, and T. H. Wu.
Water Resources Bulletin WARBAQ, Vol. 26, No. 4, p 657-667, August 1990. 11 fig, 14 ref.

Descriptors: *Groundwater budget, *Groundwater level, *Hydrologic models, *Infiltration, *Mathematical models, *Model studies, *Recharge, *Slopes, *Soil water, Alaska, Comparison studies, Drainage, Evapotranspiration, Finite difference methods, Kriging, Mathematical equations, Piezometry.

A comparative study of ground water level predictions on hillside slopes is conducted. Using a simplified mass balance model that has components for evapotranspiration, recharge and drainage; and a two-dimensional finite difference model that employs kriging to estimate soil parameters and accounts for non-uniform thickness of the soil layer. These models are representative of a wide range of modeling capabilities and are used to illustrate the sensitivity of groundwater level predictions to the sophistication of the modeling techniques. The drainage and recharge components of the two models are evaluated and the importance of unsaturated flow in recharge computations is underscored. Piezometric observations in a small drainage depression on the slope of Kennel Creek Valley in Tongass National Forest, Alaska, were used to evaluate the two models. The results show that, although the predictions differ from the field observations, the simple physically-based mass balance model predicts the groundwater levels as well as the two-dimensional model. It is suggested that caution should be exercised in using complex models to validate simpler models. (Author's abstract)
W91-03860

STRUCTURAL AND STRATIGRAPHIC FRAMEWORK OF GROUNDWATER OCCURRENCE AND SURFACE DISCHARGE IN THE MURRAY BASIN, SOUTHEASTERN AUSTRALIA.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
C. M. Brown.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 127-146, 1990. 13 fig, 96 ref.

Descriptors: *Australia, *Flow discharge, *Geochemistry, *Geohydrology, *Groundwater movement, *Murray-Darling River Basin, *Saline groundwater, *Saline soils, *Stratigraphy, Aquifer systems, Basins, Geologic history, Groundwater barriers, Groundwater basins, Literature review, Paleohydrology, Saline water, Sedimentary basins, Sedimentary structures.

Salinity problems threaten the regional economy and natural environment of the Murray Basin, an important agricultural region in Australia. Groundwater trapped within the basin can only escape by discharge to the Murray River or landscape, where salts accumulate through evapotranspiration. The basin sediments are largely water-saturated, and remaining groundwater storage capacity for increased recharge to aquifer systems is limited. Groundwater levels have therefore risen rapidly after increased infiltration from the clearing of natural vegetation for shallow-rooted plants and irrigation. The extent of characteristic assemblages of Upper Quaternary sediments and landforms shows more widespread salinization under 'natural' conditions at times in the recent geologic past. In the subsurface, a basin-wide stratigraphic framework has been established through documentation of regional distribution, geometry, and depositional environments of Tertiary units. Facies analysis of borehole data and paleogeographic reconstructions indicate at least three major depositional sequences within the Tertiary succession, each having nonmarine sediments in the east and north and marine sediments in the western areas. The stratigraphy translates into a number of regional aquifer systems, confining layers, and permeability barriers to groundwater flow, each with distinctive characteristics. The development of natural groundwater discharge sites at the surface of the basin causes flow disruption and upward leakage at subsurface permeability barriers. These barriers occur where aquifer systems of the basin are significantly thinned by concealed basement features and/or by lateral changes in lithology. (Author's abstract)
W91-03889

HYDROGEOLOGY OF THE MURRAY BASIN, SOUTHEASTERN AUSTRALIA.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
W. R. Evans, and J. R. Kellett.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 147-166, 1990. 22 fig, 2 tab, 37 ref.

Descriptors: *Aquifer systems, *Australia, *Geochemistry, *Geohydrology, *Groundwater movement, *Murray-Darling River Basin, *Saline groundwater, *Saline soils, *Soil management, *Water quality, Deterioration, Groundwater barriers, Groundwater level, Groundwater recharge, Infiltration, Saline water, Salinity, Surface-groundwater relations, Water use.

Soil degradation is the most serious environmental issue facing Australia today. and a major problem is the land salinization and degradation of surface water quality in the Murray Basin of southeast Australia. An understanding of regional groundwater processes is necessary to formulate effective management plans to combat the spread of salinity throughout the basin. Groundwater flow in all four of the aquifer groups contained within the three regional groundwater provinces is toward the Murray River, which is the sole conduit for the transport of groundwater and salts out of the basin. The major impediment to flow, the mid-Tertiary low-permeability barrier, extends in a 100-km arc through the center of the basin, and disrupts lateral throughflow in the upper two aquifer groups. This disruption is one of the factors that controls the distribution of groundwater discharge zones, which are ultimately controlled by groundwater pressure in recharge zones. Land clearing in the recharge zones has increased the rainfall infiltration capacity of soils, thereby increasing water pressure, resulting in rising water tables downbasin. The total salt load in the aquifers exceeds 100,000 million tons, and, under the current groundwater-surface water interactive flow regime, <0.004% of this huge salt store is transported out of the basin. Recoverable reserves of groundwater in the unconfined aquifers total around 4.5 million ML/year. The utilization rate is only a few percent of the sustainable yield. Greater use of groundwater in recharge zones would ultimately reduce the rate of rise of the regional down-basin water table, though salt disposal considerations are the limiting factor on any development. (Author's abstract)
W91-03890

IRRIGATION RECHARGE.
Rural Water Commission of Victoria, Armidale (Australia).
For primary bibliographic entry see Field 3F.
W91-03892

EFFECT OF LAND CLEARANCE IN THE MALLEE REGION ON RIVER MURRAY SALINITY AND LAND SALINISATION.
South Australian Dept. of Mines and Energy, Adelaide.
For primary bibliographic entry see Field 4C.
W91-03894

ASPECTS OF STRATIGRAPHY AND STRUCTURE IN RELATION TO THE WOOLPUNDA GROUNDWATER INTERCEPTION SCHEME, MURRAY BASIN, SOUTH AUSTRALIA.
South Australian Dept. of Mines and Energy, Adelaide.
J. M. Lindsay, and S. R. Barnett.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 219-225, 1990. 4 fig, 1 tab, 31 ref.

Descriptors: *Australia, *Flow discharge, *Geohydrology, *Interception, *Saline groundwater, *Stratigraphy, *Water quality control, *Woolpunda Groundwater Interception Sche, Aquifer systems, Geologic control, Groundwater barriers, Groundwater movement, Murray-Darling River Basin, Paleohydrology, Permeability, River basins.

Micropaleontological and biostratigraphic studies have been used to assist understanding the stratigraphic and structural context of groundwater flow systems in the vicinity of the Woolpunda Groundwater Interception Scheme (WGIS)--a major area of saline groundwater discharge to the River Murray in the western Murray Basin, South Australia. Structure was defined by tracing several stratigraphic markers in the Late Oligocene to Middle Miocene succession, including the Lepidocyclina foraminiferal zone and three clay or marl units of low permeability. A cross-section through the upper part of the Cenozoic sequence illustrates east-west arching, gentle Middle to Late Miocene folding, and intermittent mild Cenozoic uplift. Arching and doming across the WGIS area is confirmed by a structure contour plot on the top Renmark Group, and by limited drilling in the deeper Eocene and Cretaceous sediments. The arched structure apparently relates to draping of the Tertiary succession over a high of pre-Tertiary rocks related to the Hamley Fault. This high acts as a permeability barrier to the Renmark Group confined aquifer which thins significantly over it, promoting upward leakage into the water table aquifer, with resultant high saline discharge to the River Murray. (Author's abstract)
W91-03896

GROUNDWATER-RIVERWATER DENSITY CONTRAST: ITS EFFECT ON THE PATTERN OF GROUNDWATER DISCHARGE TO THE RIVER MURRAY.
South Australian Dept. of Engineering and Water Supply, Adelaide.
A. Telfer.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 227-232, 1990. 10 fig, 5 ref.

Descriptors: *Australia, *Density currents, *Geochemistry, *Geohydrology, *Interception, *Murray-Darling River Basin, *Saline groundwater, *Saline water barriers, *Surface-groundwater relations, *Woolpunda Groundwater Interception Sche, Aquifers, Computer models, Discharge measurement, Groundwater movement, River flow, Trenches, Water pressure.

The Woolpunda Groundwater Interception Scheme (WGIS) is being constructed along the

River Murray in South Australia, and is designed to intercept saline groundwater which is discharging into the river from the regional water table. A density contrast between river water and groundwater causes the pressure in the aquifer below the River Murray to be less than that in the aquifer adjacent to the river. The magnitude of the pressure difference is proportional to the depth of the river, and groundwater discharge is biased toward the zones of maximum pressure difference. These zones are the deepest sections of the river, herein called trenches. Groundwater entrainment from the trenches causes plumes of salinized (and hence denser) river water to flow along the bottom of the river. These plumes are fully mixed with the river water where the river is shallow. River salinity measurements and computer modeling of the density contrast effect indicate that the groundwater discharge per unit length of river is 40-60% greater at a trench than elsewhere. (Author's abstract)
W91-03897

ENVIRONMENTAL CONSEQUENCES OF SALINE GROUNDWATER INTRUSION INTO THE WIMMERA RIVER, VICTORIA.
Kaiela Fisheries Research Station, Shepparton (Australia). Fisheries Div.
J. R. Anderson, and A. K. Morison.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 233-252, 1990. 15 fig, 32 ref.

Descriptors: *Australia, *Density stratification, *Environmental effects, *Environmental impact, *Murray-Darling River Basin, *Saline groundwater, *Saline water intrusion, Anaerobic conditions, Conductivity, Geohydrology, River basins, River flow, Water quality control, Water table rise, Watershed management.

Saline groundwater intrusions into lowland reaches of the Wimmera River, western Victoria, Australia, accumulated under low-flow conditions to form stable 'saline pools.' An extensive area of river downstream was affected, and almost all water in the channel during flow stoppages appeared to be of groundwater origin. Saline pools which re-established within two months of flow decline had similar depth, temperature and conductivity to those found six months before. Under the prevailing intermittent flow regime, saline pools would be expected during the 7-month low-flow period in most years. Stable stratification and associated severe hypoxia rendered much of the water in the pools uninhabitable by aerobic organisms. The habitable area in many pools was confined to upper layers and shallow pool margins. Severe deoxygenation and rapid short term changes in salinity and temperature occurred with a 'first flush,' and displacement of partially mixed saline water produced secondary stratifications in deep pools downstream. Vertical conductivity gradients were associated with persistent deoxygenation at many sites as a result of this process. The total area affected by saline groundwater intrusion extended downstream far beyond the immediate area of the intrusion. This river provides a model for other rivers in the Murray-Darling Basin where saline groundwater from rising water tables drains into them. Further studies are required to develop management and control measures to prevent large-scale environmental degradation of riverine habitats in the Murray-Darling Basin. (Author's abstract)
W91-03898

TATIARA PROCLAIMED REGION, SOUTH-EASTERN SOUTH AUSTRALIA: HYDROGEOLOGICAL INVESTIGATIONS AND GROUNDWATER MANAGEMENT.
South Australian Dept. of Mines and Energy, Adelaide.
For primary bibliographic entry see Field 4B.
W91-03899

CHLORINE-36 MEASUREMENTS IN THE MURRAY BASIN: PRELIMINARY RESULTS FROM THE VICTORIAN AND SOUTH AUSTRALIAN MALLEE REGION.
Australian Nuclear Science and Technology Organisation, Sutherland.
R. F. Davie, J. R. Kellett, L. K. Fifield, W. R. Evans, and G. E. Calf.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 261-272, 1990. 7 fig, 1 tab, 34 ref. Australian Water Research Advisory Council Grant No. M86/16.

Descriptors: *Aquifer systems, *Australia, *Chlorine radioisotopes, *Environmental tracers, *Geochemistry, *Groundwater chemistry, *Groundwater movement, *Isotopic tracers, *Murray-Darling River Basin, *Saline groundwater, *Tracers, Geohydrology, Groundwater recharge, Mass spectrometry, Rainfall.

Chlorine-36 (36-Cl) is a naturally-occurring radioactive isotope with a half-life of 301,000 +/-2000 years, and is a natural component of recharge waters into underground aquifers. Furthermore, within the aquifer environment the highly soluble chloride ion has simple geochemistry. These attributes make 36-Cl an ideal isotope for studying salt and water movement within an aquifer system. Chlorine-36 analyses of groundwater samples from 18 wells in the Victorian and South Australian Mallee region of the Murray Basin were carried out using the technique of accelerator mass spectrometry. Results of these analyses show evidence for significant recharge from rainfall over much of the study area to the underlying Murray Group limestone aquifer. Furthermore, the 36-Cl results indicate that the major source of salts to the Murray Group groundwater covered in this study, except for the discharge zones, is recent (compared with the half-life of 36-Cl) atmospheric accession. In particular, the results are not consistent with the addition of connate salts or ancient salt evaporites to the groundwater. In addition to the groundwater flow system, 36-Cl/Cl ratios have been measured for several localized discharge zones (bionkas) north of the Big Desert. The 36-Cl/Cl ratios in these samples vary by as much as a factor of 3. This variation indicates that 36-Cl has considerable potential as a tool in the study of these features. (Fish-PTT)
W91-03900

PRACTICAL ACCOUNT OF INSTABILITIES IN IDENTIFICATION PROBLEMS IN GROUNDWATER SYSTEMS.
Australian National Univ., Canberra. Centre for Mathematical Analysis.
For primary bibliographic entry see Field 7C.
W91-03901

ORIGINS OF GROUNDWATER SALINITY NEAR TRESCO, NORTHWEST VICTORIA.
New South Wales Univ., Kensington (Australia). Centre for Groundwater Management and Hydrogeology.
M. J. Knight, and H. A. Martin.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 285-289, 1990. 7 fig, 1 tab, 12 ref.

Descriptors: *Australia, *Geochemistry, *Geohydrology, *Saline groundwater, *Saline water intrusion, Aquifer systems, Brines, Geologic history, Murray-Darling River Basin, Paleohydrology, Palynology, Playas.

The origins of saline waters in Murray Basin (Australia) aquifers and elsewhere continue to be a subject of considerable debate and controversy. Core samples and groundwater from bores at Tresco, northern Victoria, in the southern margin of the Murray Basin, have been analyzed for palynology and chemistry. An aquifer immediately above the Blanchetown Clay was initially filled with fresh water that became reducing, acidic, and rich in dissolved CO2 in the early Pleistocene. Later, between 400,000 and 18,000 years B.P., the aquifer was invaded by a series of concentrated sodium chloride water pulses. These originated from brine pools below salt playa lakes on the ground surface above the aquifer. This saline invasion significantly changed the chemical evolution path of the groundwater. A marine explanation for the observed salinity patterns is not possible. (Author's abstract)
W91-03902

IVANHOE BLOCK--ITS STRUCTURE, HYDROGEOLOGY AND EFFECT ON GROUNDWATERS OF THE RIVERINE PLAIN OF NEW SOUTH WALES.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
J. R. Kellett.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 333-353, 1990. 11 fig, 1 tab, 13 ref.

Descriptors: *Australia, *Geochemistry, *Geohydrology, *Geologic control, *Groundwater movement, *Murray-Darling River Basin, *Paleohydrology, *Saline groundwater, Flow discharge, Geologic fractures, Groundwater barriers, Land clearing, River basins, Salts, Water table rise.

The Ivanhoe Block is a faulted and uplifted concealed basement ridge complex underlying the mallee sand dunes adjacent to the New South Wales part of the Western Riverine Plain in the central Murray Basin in southeastern Australia. The parallel basement ridges of the Ivanhoe Block deflect flow south in the deeper aquifers, and thinner beds on top of the ridges result in convergence of flow in the shallower aquifers. Groundwater salinity is strata-bound in the aquifers of the Ivanhoe Block and Western Riverine Plain. This Plain is the regional groundwater discharge zone for the eastern Murray Basin in New South Wales, and it has been created by the impeding action of the bounding Ivanhoe Block. The Western Riverine Plain is partitioned into the Balranald-Hatfield discharge zone in its western half (defining the zone of salt production and accumulation in the shallower Tertiary aquifers) and the Moulamein-Mossgiel buffer zone in its eastern half (defining the maximum historical extent of up-basin propagation of refluxed salts). In recent years the Ivanhoe Block has been the focus of growing community concern about clearing in the mallee lands and the susceptibility of these areas to land salinization. The Balranald-Hatfield discharge zone and the lower Willandra Lakes are most at risk from land salinization if water tables continue to rise. The Moulamein-Mossgiel buffer zone is in the second-highest risk category, and the eastern Riverine Plain has a low risk of salinization in its non-irrigated lands. (Author's abstract)
W91-03905

GEOLOGICALLY INDUCED SALINITY AT YELARBON, BORDER RIVERS AREA, NEW SOUTH WALES, QUEENSLAND.
New South Wales Univ., Kensington (Australia). Centre for Groundwater Management and Hydrogeology.
M. J. Knight, B. J. Saunders, R. M. Williams, and J. Hillier.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 355-361, 1990. 13 fig, 2 tab, 11 ref.

Descriptors: *Australia, *Geochemistry, *Geohydrology, *Geologic control, *Murray-Darling River Basin, *Saline groundwater, *Saline soils, Darling River Basin, Geologic fractures, Geophysical surveys, Land management, Land use, Landsat images, Surface drainage, Tectonics, Water chemistry.

Dryland salinity has been gaining importance as a major environmental issue in Australia over the last 20 years. Particular focus has been given in recent times to the Murray-Darling River Basin, where loss of land productivity due to salinization is growing at a considerable rate. A dryland salinity scald approximately 48 sq km in size has been described near Yelarbon on the border of Queensland and New South Wales, near the headwaters of the Murray-Darling River Basin. The saline soils, including solodized solonetz, are severely eroded and readily identified on Landsat MSS imagery. A major fault beneath the scald has caused saline groundwater to leak up into the soil zone preferentially at this location. The evidence for this includes regional tectonic setting, detailed site geolo-

gy, a magnetic geophysical anomaly, surface drainage changes and land surface displacement, hydraulic gradient changes, and groundwater hydrochemical anomalies. Erosion of the geologically caused saline scald is being aggravated by overgrazing. An appropriate land management strategy is to fence the area and assign it nature reserve or national park status. (Author's abstract)
W91-03906

APPLICATION OF LANDSAT THEMATIC MAPPING TO GEOLOGY AND SALINITY IN THE MURRAY BASIN.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
For primary bibliographic entry see Field 7B.
W91-03907

STRATIGRAPHY AND SEDIMENTOLOGY OF MID-TERTIARY PERMEABILITY BARRIERS IN THE SUBSURFACE OF THE MURRAY BASIN, SOUTHEASTERN AUSTRALIA.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
C. M. Brown, and B. M. Radke.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 367-385, 1990. 10 fig, 6 tab, 51 ref.

Descriptors: *Australia, *Geochemistry, *Geologic history, *Geology, *Groundwater barriers, *Murray-Darling River Basin, *Paleohydrology, *Saline groundwater, *Sedimentation, *Stratigraphy, Clays, Confining beds, Geohydrology, Groundwater movement, Marine environment, Permeability, Porosity, River basins, Water resources management.

In the Murray Basin of southeastern Australia, the accelerated emergence of groundwater-related salinity problems in recent decades has led to the realization that future viability of many of its agricultural communities depends on management of its water resources. Part of the management strategy involves understanding the stratigraphy, distribution, and geometry of units deposited in the mid-Tertiary which now form major subsurface permeability barriers. Subsurface facies analysis of borelogs and paleogeographic reconstructions indicate that the Murray Basin has been invaded by the sea on three occasions during the Cenozoic. In the mid-Oligocene, thin calcareous clay of the lower confining layer was deposited over much of the southwest of the basin, and now separates the underlying Renmark Group aquifer system from the overlying Murray Group aquifer system, but does not impede the groundwater flow from the margins of the basin to the center. As relative sea level continued to rise in the late Oligocene, the thin sediments of the lower confining layer were overlain by thicker limestones, grading laterally into thick calcareous clay (Winnambool Formation) and terrigenous clastics (Geera Clay), which combine to form the mid-Tertiary low-permeability barrier that causes major disruption to the groundwater flow towards the basin center. The Geera Clay is an important subsurface barrier, resulting in flow diversion into the overlying aquifer system. The effective porosity of the Geera Clay was found to be 0-7%, whereas the original porosity was estimated at 5-30%. Burrow interparticle porosity predominated. The occlusion of effective interparticle porosity was caused by mineral precipitation at an early stage. (Author's abstract)
W91-03908

DEVICE FOR IN SITU DETERMINATION OF GEOCHEMICAL TRANSPORT PARAMETERS: 2. BIOCHEMICAL REACTIONS.
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 7B.
W91-03909

DETERMINATION OF SPECIFIC STORAGE BY MEASUREMENT OF AQUIFER COMPRESSION NEAR A PUMPING WELL.
Geological Survey, Denver, CO.
S. G. Robson, and E. R. Banta.
Ground Water GRWAAP, Vol. 28, No. 6, p 868-874, November/December 1990. 7 fig, 1 tab, 18 ref.

Descriptors: *Aquifer characteristics, *Aquifer testing, *Confined aquifers, *Groundwater movement, *Pumping tests, *Storage capacity, Compression, Drawdown, Field tests, Groundwater data, Mathematical studies, Observation wells, Pump wells, Storage coefficient, Theis equation.

Aquifer tests of confined aquifers in deep formations can yield inaccurate specific storage and storage coefficient estimates if the distance between the pumped and observation wells is imprecisely known. The distance between the wells can be uncertain because small deviations in the vertical alignment of deep wells can markedly change the distance between the perforated intervals of the wells. Uncertain distance between wells may seriously degrade the accuracy of specific storage or storage coefficient values calculated from aquifer test data obtained from closely-spaced wells. A method has been proposed whereby compression of the aquifer matrix can be measured during an aquifer test and used to calculate specific storage and storage coefficient values without the knowledge of the distance between the pumped and observation wells. In a field trial of the method, specific storage and storage coefficient values calculated form aquifer compression data were 0.000000816 and 0.000304, which is nearly identical to values (0.000000804 and 0.000299) obtained from longer-term monitoring of aquifer barometric efficiency. Additional comparison with results of a Theis analysis of drawdown data indicates that the aquifer compression data may provide a more accurate determination of specific storage and storage coefficient values than would be possible even if the vertical alignment of the pumped and observation wells had been surveyed. (Author's abstract)
W91-03911

SHALLOW WEATHERED FRACTURE LAYER IN THE NEAR-STREAM ZONE.
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
W. J. Gburek, and J. B. Urban.
Ground Water GRWAAP, Vol. 28, No. 6, p 875-883, November/December 1990. 10 fig, 2 tab, 16 ref.

Descriptors: *Geologic control, *Geologic fractures, *Groundwater movement, *Surface-groundwater relationships, *Watersheds, Cores, Cross-sections, Flow pattern, Hydraulic conductivity, Land use, Piezometers, Stream discharge, Water quality.

The bedrock profile of an east-central Pennsylvania watershed contains a shallow weathered fracture layer. To begin quantifying the effects of this fracture layer on groundwater movement, two valley cross sections were chosen for detailed investigation. One section represents the typical upland watershed situation where the regional groundwater is in contact with the stream for only part of the year, while at the other section the regional groundwater is in perennial contact with the stream. Rock cores extracted from the sections reveal a pattern of extensive fracturing to approximately 50 feet directly under the stream thinning to a relatively uniform 30-ft deep fracture layer away from the channel. Limited seismic investigations support these observations. Piezometers within each cross section show that there is great variability in conductivity within the fracture layer itself. Lateral flow generally occurs within the fracture layer to within approximately 50 ft of the stream; here a converging flow pattern indicates groundwater discharge to the stream. Under wet conditions, the stream in each section serves as a point of groundwater discharge, while under dry conditions, the more upland section shows no groundwater discharge to the land surface. Rather, subsurface flow is likely occurring beneath and parallel to the channel controlled by a discharge point at some downstream location. Finally, water quality samples from the piezometers indicate a direct effect of overlying land use on water quality within the shallow fracture layer. (Author's abstract)
W91-03912

PARTICLE-TRACKING ANALYSIS OF FLOW PATHS AND TRAVELTIMES FORM HYPOTHETICAL SPILL SITES WITHIN THE CAPTURE AREA OF A WELLFIELD.
Ohio State Univ., Columbus. Dept. of Geology and Mineralogy.
For primary bibliographic entry see Field 5B.
W91-03913

EVALUATION OF AQUIFER BEHAVIOR AND CHARACTERISTICS IN THE SINGRAULI COALFIELD, CENTRAL INDIA.
Indian School of Mines, Dhanbad. Dept. of Applied Geology.
V. D. Choubey, and I. Shankaranarayana.
Ground Water GRWAAP, Vol. 28, No. 6, p 893-899, November/December 1990. 9 fig, 4 tab, 11 ref.

Descriptors: *Aquifer characteristics, *Coal mining effects, *Groundwater management, *Groundwater movement, *India, *Water pollution control, Aquifer systems, Confined aquifers, Field tests, Geohydrology, Groundwater recharge, Hydraulic conductivity, Infiltration, Pump wells, Pumping tests, Surface-groundwater relations, Transmissivity, Unconfined aquifers.

Hydrological investigations were conducted to determine the aquifer characteristics, recharge boundary location, and the amount of groundwater which can be withdrawn safely in order to minimize potential groundwater contamination from open pit coal mining. The impact of surface mining of coal on the groundwater system in the Singrauli Coalfield, Central India, was investigated. Field studies measured the infiltration characteristics of surface-mined land, determined surface water runoff, and analyzed the geohydrologic impacts of surface mining. Analysis of data obtained from boreholes in the study area has revealed two aquifers: an unconfined aquifer composed of medium-grained sandstone, and a confined aquifer composed of medium-to-coarse-grained sandstone. A pumping test conducted on the confined aquifer found values of transmissivity, storage coefficient, and hydraulic conductivity to be 84.14 sq m/day, 0.0004076, and 4,200 cu m/day, respectively, and a recharge boundary located at a distance of 163 m. The recharge boundary was, in fact, determined to be a north-south trending stream situated at about 200 m from the pumping well, closely corroborating the field situation with pump test data. From these studies it was concluded that water supply wells should be completed in the confined aquifer. The large-scale surface coal mining disrupts the shallow groundwater levels within 7-10 km of the cut. At deeper surface mines, water levels may be lowered as much as 70 to 100 m in the shallow aquifer. The water table level reestablishes itself when mining activity stops. This study provides the framework for three-dimensional analysis of such problems as the geohydrology, risk of potential contamination, mine flooding, highwall stability, and reclaimed land surface. (Author's abstract)
W91-03914

INFLUENCE OF AQUIFER HETEROGENEITY ON CONTAMINANT TRANSPORT AT THE HANFORD SITE.
Colorado School of Mines, Golden. Dept. of Geology and Geological Engineering.
For primary bibliographic entry see Field 5B.
W91-03915

COLUMN STUDIES ON METHANOTROPHIC DEGRADATION OF TRICHLOROETHENE AND 1,2-DICHLOROETHANE.
Sonnenschein Nath and Rosenthal, Washington, DC.
For primary bibliographic entry see Field 5G.
W91-03916

EFFECT OF SENSOR ERROR ON INTERPRETATION OF LONG-TERM WATER-LEVEL DATA.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 7B.
W91-03918

ANALYSIS TECHNIQUE FOR MULTILEVEL AND PARTIALLY PENETRATING SLUG TEST DATA.
South Carolina Univ., Columbia. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W91-03919

NUMERICAL GENERATION OF FLOW NETS--THE FLOWNS MODEL.
North Carolina State Univ. at Raleigh. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W91-03920

2G. Water In Soils

EVALUATION OF GROUND-WATER RECHARGE ALONG THE GILA RIVER AS A RESULT OF THE FLOOD OF OCTOBER 1983, IN AND NEAR THE GILA RIVER INDIAN RESERVATION, MARICOPA AND PINAL COUNTIES, ARIZONA.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-02977

STRUCTURE AND APPLICATION OF AN INTERFACE PROGRAM BETWEEN A GEOGRAPHIC-INFORMATION SYSTEM AND A GROUNDWATER FLOW MODEL.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-02980

BIODEGRADATION OF PCP CONTAMINATED SOILS USING IN SITU SUBSURFACE BIORECLAMATION.
Keystone Environmental Resources, Inc., Monroeville, PA.
For primary bibliographic entry see Field 5G.
W91-03100

UPDATE ON IN SITU BIOREMEDIATION OF THE FRENCH LIMITED SUPERFUND SITE.
ENSR-Celgene, Inc., Houston, TX.
For primary bibliographic entry see Field 5G.
W91-03101

PILOT-SCALE BIOREMEDIATION OF CHLORINATED SOLVENT AND PNA-CONTAINING SOILS.
Monsanto Chemical Co., St. Louis, MO.
For primary bibliographic entry see Field 5G.
W91-03104

BIOREMEDIATION OF HEAVY PETROLEUM OIL IN SOIL AT RAILROAD MAINTENANCE YARD.
For primary bibliographic entry see Field 5G.
W91-03107

DESERT ENCROACHMENT IN EGYPT'S NILE VALLEY.
Minya Univ. (Egypt). Soil Science Dept.
M. A. Kishk.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 15-23, 3 fig, 3 tab, 15 ref.

Descriptors: *Arid lands, *Desertification, *Egypt, *Nile Valley, *Soil properties, Deserts, Monitoring, Remote sensing, Soil degradation, Soil texture.

The River Nile plays an enormously important role in the life of Egypt. Studies conducted at Minia and Assiut Universities over the past 10 yr are summarized. Two hundred and seventy-six soil samples were collected at 79 sites located along lines perpendicular to the River Nile and covering an area extending from Aswan in the south to Giza in the North. Most soils located near the Nile have generally fine texture, whereas soils in the interference zone (where desert and Nile soils mix) are coarser. Alluvial soils near the river differ in several respects, as follows: darker color than interference zone soils; lower total carbonate content than interference zone soils (2.8% vs 15.2% average values); higher organic matter content (average 1.24% vs 0.23% in the interference zone; higher cation exchange capacity (32.5 meq/100 g vs 9.1 meq/100 g of soil); different mineral composition reflecting the increased amount of intermixed desert soils in the interference zone; and various other indications of desert encroachment. Desert encroachment represents a great danger to Egypt's cultivated soils and the affected areas should be mapped. A rough estimate of the affected area is 720,000 ha, which represents about one-third of Egypt's cultivated land. Three recommendations are made: (1) desert encroachment should be considered one of the most important challenges to agricultural development in Egypt; (2) measures should be implemented to prevent further mixing of desert sediments with cultivated soils; and (3) remote sensing and other techniques should be employed to monitor the changes in the extent of desert encroachment over time. (See also W91-03117) (Rochester-PTT)
W91-03120

EXPLORATION OF FRACTURED ZONES BY RADON DETERMINATION IN THE SOIL.
T. Pointet.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 37-46, 3 fig, 1 tab, 6 ref.

Descriptors: *Borehole geophysics, *Developing countries, *Environmental tracers, *Geologic fractures, *Radon radioisotopes, *Tracers, *Water resources development, Africa, Burkina Faso, Geohydrology, Geophysical methods, Groundwater management, Groundwater mining, Groundwater movement, Groundwater potential, Soil gases, Water demand, Water resources management, Water yield improvement.

The exploration of aquifer environments in basement rocks, like most aspects of hydrogeology of fractured environments, is marked by their discontinuous character. The statistical study of yields obtained from several tens of thousands of boreholes in African crystalline rocks shows that 15% of them produce more than 5 cu m/ hour. The usual geological analysis however does not determine why one borehole has a small or a high yield. By these methods alone, it is impossible to propose siting rules which would significantly increase the possibility of obtaining large yields. The water demand is presently increasing. The predictable development of irrigated farming and potable water supply of small towns from groundwater supposes that one will be able to find high individual yields in the basement zones with high enough success rates to justify research costs. By turning towards less traditional techniques inspired by structural geology and the study of fracture networks, it has been observed that the radon contained in the soil gases act as an efficient natural tracer, by underlining the presence of permeable zones in a fractured massif. Systematic prospecting by radon dosing in the soil gases brings out locally-concentrated anomalies. The boreholes drilled immediately below these anomalies are usually very productive. Applied to prospecting, the method was tested in Burkina-Faso along with electric and electromagnetic geophysical methods, and with siting techniques based on structural analysis. In environments of crystalline and metamorphic rocks, the water yields obtained from boreholes sited on radon anomalies are distinctly higher than those from boreholes sited by other methods. (See also W91-03178) (Author's abstract)
W91-03181

GROUNDWATER FLOW IN UNSATURATED/SATURATED ZONES.
Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 2F.
W91-03185

ESTIMATING GROUNDWATER RECHARGE USING SURFACE AND SOIL WATER BALANCES.
Institute of Hydrology, Powys (Wales).
For primary bibliographic entry see Field 2F.
W91-03186

INTERACTION BETWEEN THE GROUNDWATER AND UNSATURATED SOIL-WATER FLOW REGIONS.
Rothamsted Experimental Station, Harpenden (England).
For primary bibliographic entry see Field 2F.
W91-03187

INSENSITIVITY OF REMOTE SENSING TO WATER-LOGGING IN LOW-CAPILLARITY SOILS.
Punjab State Council for Science and Technology, Chandigarh (India).
For primary bibliographic entry see Field 7B.
W91-03418

MATHEMATICAL ZERO-INERTIA MODELING OF SURFACE IRRIGATION: ADVANCE IN BORDERS.
Institut de Mecanique de Grenoble, Saint-Martin d'Heres (France).
For primary bibliographic entry see Field 3F.
W91-03420

CLIMATE CHANGE AND THE POTENTIAL IMPACT ON THE SOIL RESOURCE.
Agricultural Research Service, Ames, IA.
For primary bibliographic entry see Field 2B.
W91-03431

ELECTROCHEMICAL PROCESSING OF SOILS: THEORY OF PH GRADIENT DEVELOPMENT BY DIFFUSION, MIGRATION, AND LINEAR CONVECTION.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W91-03539

MEASURING THE HYDRAULIC PROPERTIES OF A STABLE AGGREGATED SOIL.
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Soils.
K. R. J. Smettem, and C. Kirkby.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 1-13, September 1990. 5 fig, 3 tab, 24 ref.

Descriptors: *Hydraulic conductivity, *Hydraulic properties, *Soil aggregates, *Soil properties, *Soil water, Diffusivity, Flow models, Mathematical analysis, Permeability, Sorptivity.

Reliable modeling of soil-water flow requires accurate and convenient measurement of the appropriate soil hydraulic properties, which can be particularly problematic in structured soils with a distinct macropore-matrix dichotomy in the flow regime. The hydraulic properties of an aggregated soil at water supply potentials near saturation were obtained using the disc permeameter. The sorptivity, the hydraulic conductivity, and the wetting soil-water characteristic were measured directly. The soil-water diffusivity was derived from measurements of hydraulic conductivity and wetting soil-water characteristic and was also shown to be well described by deconvoluting the sorptivity using the Parlange approximation. This description of soil-water diffusivity conveniently supplements es-

timates obtained over a wider range of water contents using the absorption method of Bruce and Klute, with water content profiles obtained by gamma scanning. Finally, the measured hydraulic conductivity function was accurately described by introduction of a method for scaling the wetting soil-water characteristic over the inter-aggregate and intra-aggregate flow regions and matching to the measured hydraulic conductivity at two points. (Author's abstract)
W91-03540

ORIGIN OF SALINE SOILS AT BLACKSPRING RIDGE, ALBERTA, CANADA.
Alberta Research Council, Edmonton. Terrain Sciences Dept.
For primary bibliographic entry see Field 2F.
W91-03544

PARAMETER IDENTIFICATION OF SOLUTE TRANSPORT MODELS FOR UNSATURATED SOILS.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W91-03549

AIR PERMEABILITY MEASUREMENTS OF THE UNSATURATED BANDELIER TUFF NEAR LOS ALAMOS, NEW MEXICO.
Oak Ridge National Lab., TN.
P. M. Kearl, R. J. Zinkl, J. J. Dexter, and T. Cronk.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 225-240, September 1990. 4 fig, 2 tab, 21 ref.

Descriptors: *Aeration zone, *Bandelier Tuff, *New Mexico, *Path of pollutants, *Permeability, *Radioactive waste disposal, *Soil water, *Tuff, *Unsaturated flow, Air permeability, Analytical methods, Geologic formations, Los Alamos, Measuring instruments, On-site investigations, Porous media.

The Bandelier Tuff near Los Alamos, New Mexico, is located approximately 200 m above the regional water table. Because of the distance to the water table, organic and radioactive wastes were disposed of in unlined trenches and shafts within the tuff. Concerns regarding the movement of the contaminants, particularly in the vapor phase, prompted a site investigation. Part of that investigation included the determination of the permeability of the tuff. Three methods which measure the intrinsic permeability were used: air injection, vacuum testing, and laboratory testing of rock core samples. Dual packers were used to isolate specific zones for the air injection and vacuum tests. Klinkenburg and dynamic methods were used to measure permeabilities in the laboratory. Comparison of the results showed that vacuum tests produce results which are in good agreement with the laboratory permeabilities for unfractured zones. Permeabilities measured with air injection tended to be as much as an order of magnitude higher than those measured by the other methods. For estimates of the intrinsic permeability in the unsaturated zone, however, both air injection and vacuum tests are reliable methods. Because consolidated core samples are required for laboratory testing, it was concluded that field test results are the more reliable indicators of bulk permeabilities. (Author's abstract)
W91-03550

EVALUATION OF THE HYDROGEOLOGIC SYSTEM IN DISPOSAL OF MIXED WASTES.
Argonne National Lab., IL.
For primary bibliographic entry see Field 5E.
W91-03594

ROLE OF CROP RESIDUE MANAGEMENT IN NITROGEN CYCLING USE.
Agricultural Research Service, Lincoln, NE.
For primary bibliographic entry see Field 3F.
W91-03639

HYDROLOGIC CHARACTERISTICS OF SOILS IN THE HIGH PLAINS, NORTHERN GREAT PLAINS, AND CENTRAL TEXAS CARBONATES REGIONAL AQUIFER SYSTEMS.
Geological Survey, Lincoln, NE. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-03671

ELECTRICAL-HYDRAULIC PROPERTIES OF UNSATURATED OTTAWA SANDS.
Army Engineer District, Omaha, NE.
T. Gorman, and W. E. Kelly.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 1-18, October 1990. 8 fig, 7 tab, 22 ref. U.S. Geological Survey grant No. 14-08-0001-G1133.

Descriptors: *Artificial recharge, *Electrical properties, *Hydraulic properties, *Sand, *Soil water, *Unsaturated flow, *Vadose zone, Aeration zone, Groundwater recharge, Hydraulic conductivity, Moisture equivalent, Permeability, Resistivity, Saturated soils.

Relations between the electrical properties of unsaturated vadose zone sediments and their saturated hydraulic conductivity provide a basis for using surface electrical measurements to estimate the potential for artificially recharging groundwater at a site. Laboratory measurements of moisture equivalent (specific retention), saturated permeability, hydraulic conductivity, and electrical resistivity were made on a series of uniform, very fine or medium grain size Ottawa sands. For these sediments, the unsaturated form of Archie's law was shown to be adequate. The experimental results were combined and interpreted to demonstrate a relationship between the apparent formation factor and/or resistivity at the moisture equivalent and saturated hydraulic conductivity for the same sediment. These laboratory results provide a limited experimental basis for relationships between the resistivity of vadose zone sediments and their saturated hydraulic conductivity. (Author's abstract)
W91-03737

RESISTIVITY-RECHARGE RELATIONSHIPS--FIELD STUDY.
Nebraska Univ., Lincoln. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-03739

TRACING THE ORIGIN OF NATURAL WATERS IN A GLACIAL TILL SLOPE DURING SNOWMELT.
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Land and Water Resources.
For primary bibliographic entry see Field 2C.
W91-03743

EVOLUTION OF THE CHEMICAL COMPOSITION OF WATER PASSING THROUGH THE UNSATURATED ZONE TO GROUND WATER AT AN EXPERIMENTAL SITE AT THE UNIVERSITY OF SAO PAULO, BRAZIL.
Sao Paulo Univ. (Brazil). Inst. de Geociencias.
For primary bibliographic entry see Field 2F.
W91-03747

HYDRAULIC PROPERTIES IN AN OPERATIONAL MODEL OF FROZEN SOIL.
Uppsala Univ. (Sweden). Naturgeografiska Inst.
For primary bibliographic entry see Field 2C.
W91-03754

ECOSYSTEM DEVELOPMENT IN DIFFERENT TYPES OF LITTORAL ENCLOSURES.
Agricultural Univ., Wageningen (Netherlands). Dept. of Nature Conservation.
For primary bibliographic entry see Field 2H.
W91-03793

HYDROGEOLOGICAL PROPERTIES OF THE MATRIX OF THE CHALK IN THE LUBLIN COAL BASIN (SOUTHEAST POLAND).
Academy of Mining and Metallurgy, Krakow (Poland). Inst. of Hydrogeology and Engineering Geology.
For primary bibliographic entry see Field 2F.
W91-03843

DYNAMICS AND ORIGIN OF SALINE SOILS ON THE SLIMS RIVER DELTA, KLUANE NATIONAL PARK, YUKON TERRITORY.
Calgary Univ. (Alberta). Dept. of Geography.
For primary bibliographic entry see Field 2C.
W91-03865

2H. Lakes

HYDROLOGY, AQUATIC MACROPHYTES, AND WATER QUALITY OF BLACK EARTH CREEK AND ITS TRIBUTARIES, DANE COUNTY, WISCONSIN, 1985-86.
Geological Survey, Madison, WI. Water Resources Div.
S. J. Field, and D. J. Graczyk.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4089, 1990. 38p, 22 fig, 13 tab, 49 ref.

Descriptors: *Aquatic plants, *Black Earth Creek, *Trout, *Water quality, *Wisconsin, Biomass, Dissolved oxygen, Nitrogen, Phosphorus, Sediment yield, Stream discharge, Water temperature.

An intensive monitoring program of Black Earth Creek and its tributaries, in southern Wisconsin was conducted from October 1983 through September 1986, to define aquatic macrophytes, water quality, and the hydrologic factors that affect trout populations. Streamflows for water years 1985 and 1986 were 44 and 60% greater than the long-term average (1955-86). The highest average annual discharge since 1954, 53.4 cu ft/sec, was recorded in water year 1986. The data indicate that trout populations may be related to average annual streamflow because of greater water volumes and colder water temperature. Summer storm runoff resulted in decreased dissolved-oxygen content in two streams studied. During one storm, dissolved oxygen in Black Earth Creek decreased 3.0 mg/L and was less than 6.0 mg/L (the minimum State standard for trout) for 30 hours. Aquatic macrophyte biomass in Black Earth Creek was substantially less in 1986 than in 1985 because of substrate scouring from a flood in July 1985. Discharge from point and nonpoint sources affects Black Earth Creek's water quality. Warm water discharged from a gravel pit increased water temperatures from 2 C to 4 C. Detention ponds in the Brewery Creek basin appear to effectively control suspended-sediment and phosphorus runoff during periods of moderate runoff; this basin had the highest concentration of suspended sediment and total phosphorus but did not have the highest yields of the basins studied. Suspended-sediment yields in water year 1985 were 29% greater than the 12-year-average yields (1955-65, 1985). (USGS)
W91-02974

MAPPING RIPARIAN/WETLAND HABITATS OF THE NEZ PERCE NATIONAL FOREST. A COOPERATIVE APPROACH.
Fish and Wildlife Service, Portland, OR.
For primary bibliographic entry see Field 7B.
W91-03050

ANALYSIS OF WETLAND LOSS IN LAKE GEORGE BASIN USING HISTORICAL AERIAL PHOTOGRAPHY.
State Univ. of New York Coll. at Plattsburgh. Center for Earth and Environmental Science.
G. K. Gruendling, D. J. Bogucki, and R. P. Curran.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 6A-25--6A-34, 2 fig, 5 tab, 7 ref.

Descriptors: *Aerial photography, *Lake George, *Land use, *New York, *Urbanization, *Water

management, *Wetlands, Data interpretation, Drainage effects, Habitats, History.

The Warren County shoreline of Lake George, New York, was investigated for wetland loss and resultant land use change using historical aerial photography (1946-1986). Approximately one-half of the wetlands in the study area had received some impact from development since 1948, with a total wetland habitat loss of 58.2 ha (143.6 acre) or 27.2% of the original wetland area. The bulk of the wetland loss was from filling for urban and residential development. Most wetland alterations occurred prior to 1978. The enactment of two major wetland protection measures by the State of New York has apparently eliminated serious wetland loss in spite of increasing developmental pressures in the Lake George region. (See also W91-03032) (Author's abstract)
W91-03051

SIMULATION OF WETLAND FLOW DYNAMICS.
South Florida Water Management District, West Palm Beach. Dept. of Resource Management.
P. D. Scarlatos, and T. S. Tisdale.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 9A-15--9A-23, 4 fig, 7 ref.

Descriptors: *Flow profiles, *Hydrologic models, *Model studies, *Simulation analysis, *Wetlands, Data interpretation, Drought, Flood flow, Florida, Hydrologic profiles, Infiltration.

Wetlands are ecological systems with unique hydrologic characteristics. Flat terrain, high water tables, and dense vegetation comprise a physical system which is prone to frequent inundation. Due to their ecological value, wetlands have attracted the interest of the public, and subsequently that of the scientific community. An in-depth research regarding wetlands requires the integration of different disciplines such as ecology, forestry, soil chemistry, biology, hydrology, hydraulics, economics and resource management. However, the basis for efficient management of a wetland system depends on a good understanding of the water balance and water dynamics of the system. This can be achieved by mathematically modeling the water movement. Special features of the system that effect its hydrodynamics are high bed friction and surface groundwater interactions. A numerical model for simulating wetland flow dynamics was developed, with the governing equations those for a one-dimensional, depth integrated system. The model can simulate the flooding and drying of wetlands, and the effects of groundwater infiltration. It has the capability to incorporate the effects of infiltration, evapotranspiration, precipitation, lateral inflows, and variable topography. The model was calibrated and tested for an experimental marsh area in southern Florida, and simulated results showed satisfactory agreement with field data. (See also W91-03032) (Lantz-PTT)
W91-03066

FISHERY FUNCTIONS AND VALUES OF FORESTED RIPARIAN WETLANDS.
Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures.
J. H. Crance, and L. S. Ischinger.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 14A-9--14A-16, 1 fig, 43 ref.

Descriptors: *Ecosystems, *Fisheries, *Forest watersheds, *Riparian waters, *River fisheries, *Wetlands, Flood plains, Productivity, Species diversity, Water resources development.

Relationships between freshwater forested flood plain wetlands in the southeastern US and the associated riverine fishery resources are reviewed, and management implications and research needs are discussed in this paper. Forested riparian wetlands provide spawning and nursery habitats for more than 90 species of fish, and the annual fishery harvest from some of the most productive wetlands has exceeded 8,000 kg/sq km. These wetlands also import, store, produce, and recycle materials used in food chains in situ, and are a source of residual materials used in downstream food chains. Wetland characteristics that respond to hydrologic regimes include productivity, species diversity and structure, nutrient cycling, and fish habitat quality and quantity. Thus, anthropogenic changes that affect hydrologic regimes and the fishery resources of these wetlands should be considered when stream corridor developments are evaluated. (See also W91-03032) (Author's abstract)
W91-03084

SUWANNEE RIVER ESTUARY: AN OVERVIEW AND RESEARCH AND MANAGEMENT NEEDS.
Suwannee River Water Management District, Live Oak, FL.
R. A. Mattson, and M. E. Rowan.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 14B-17--14B-31, 3 fig, 2 tab, 13 ref.

Descriptors: *Estuaries, *Florida, *Management planning, *Research priorities, *Suwannee River Estuary, Vegetation, Water quality, Water resources development, Water resources management.

The Suwannee River is the second largest river in Florida in terms of discharge and its estuary is one of the least disturbed by man's activities in the State. The estuary is also one of the least studied, yet it is one of the largest estuarine systems on the Gulf Coast of Florida and is the largest single estuary on the Florida Big Bend coast. Surface area at mean high water has been reported to be 14,336 ha; but the actual area of the estuary is difficult to determine, as it is not a semi-enclosed bay. The estuary was characterized based on existing data and studies, with respect to temperature, salinity, conductivity, pH, turbidity, dissolved oxygen, alkalinity, orthophosphate, nitrates, ammonia, chlorophyll a, fish and wildlife resources, and vegetation. Research and management needs for the estuary were identified in order to develop an effective management plan supported by competent data, and emphasize water quality protection, minimum standards, habitat preservation, and basin resource planning issues. (See also W91-03032) (Author's abstract)
W91-03094

SPATIAL SIMULATION TO AID IN EVALUATING AND TREATING EROSION AND WATER QUALITY PROBLEMS AFFECTING LAKE ERIE.
Purdue Univ., Lafayette, IN. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W91-03164

SCUDDER'S POND RESTORATION PROJECT FOR VILLAGE OF SEA CLIFF AND TOWN OF OYSTER BAY, NASSAU COUNTY, NEW YORK.
Envirodyne Engineers, Inc., New York.
For primary bibliographic entry see Field 5G.
W91-03218

WETLAND CREATION AND RESTORATION: THE STATUS OF THE SCIENCE.
For primary bibliographic entry see Field 2L.
W91-03244

CREATION, RESTORATION, AND ENHANCEMENT OF MARSHES OF THE NORTHCENTRAL GULF COAST.
Louisiana State Univ., Baton Rouge. School of Forestry, Wildlife and Fisheries.
R. H. Chabreck.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 125-142, 2 tab, 44 ref, 2 append.

Descriptors: *Artificial wetlands, *Coastal marshes, *Louisiana, *Water resources management, *Wetland restoration, *Wetlands, Alabama, Diversion, Drainage engineering, Dredging, Environmental engineering, Levees, Marsh management, Mississippi, Planting management, Salt marshes, Sedimentation, Texas, Tidal marshes, Vegetation establishment, Water resources development, Weirs.

Coastal marshes of the northcentral Gulf Coast comprise almost 50% of the coastal marshes of the United States, excluding Alaska. Over 80% of the marshes in this region occur in Louisiana because of the influence of the Mississippi River. Salt, brackish, intermediate, and fresh marshes are well-represented within the region. Marshes have been created from dredged material deposited in shallow waters and by controlled diversion of river flow to direct sedimentation to specific sites. Plantings are seldom made on dredged material in Louisiana because of the large area to be planted and the fact that natural colonization is rapid. In fresher marshes, dredged material is left as levees after canals are dug that connect to salt water sources. Levees reduce salt water contamination and drainage of the marsh. Dredge material is usually planted in Texas, Mississippi, and Alabama to stabilize the material and hasten marsh development. In tidal marshes, construction of weirs is the most widely used enhancement practice. Impoundments provide a mechanism for controlling water depth and salinity and regulating plant growth. But impoundments can only be constructed in marshes that will support a continuous levee system. Freshwater diversion from the Mississippi River has been used on a small scale for marsh restoration and enhancement but could be used to improve vast areas of the rapidly deteriorating marshes of southeastern Louisiana. Precise information is needed on subsidence rates of individual localities for planning marsh creation and restoration projects. Methods for maximizing subdelta development and determining best use of dredged material are needed. (See also W91-03244) (Author's abstract)
W91-03249

CREATION AND RESTORATION OF FORESTED WETLAND VEGETATION IN THE SOUTHEASTERN UNITED STATES.
A. F. Clewell, and R. Lea.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 195-231, 6 fig, 98 ref, 3 append.

Descriptors: *Artificial wetlands, *Forest ecosystems, *Swamps, *Vegetation establishment, *Water resources management, *Wetland restoration, *Wetlands, Hardwood, Oak trees, Plant populations, Planting management, Soil-water-plant relationships, Trees, Vegetation regrowth, Water resources development.

A wide variety of forest establishment techniques have been employed, some with initial success, but most are too new for critical evaluation. Most of these projects pertain to bottomland hardwood and cypress replacement. The two most significant trends in project activity have been the direct seeding of oaks on abandoned croplands and the replacement of all trees and sometimes the undergrowth at reclaimed surface mines. Project success depends largely on judicious planning and careful execution. The most critical factor for all projects is to achieve adequate hydrological conditions. Other important factors may include substrate stability, availability of adequate soil rooting volume and fertility, and the control of herbivores and competitive weeds. Success criteria for evaluating extant projects throughout the southeast need to place emphasis on the presence of preferred species and on the attainment of a threshold density of trees that are at least two meters tall. At that point, release from regulatory liability should be seriously considered. Several critical information gaps have been identified: (1) the sylvicultural literature warrants further investigation of wetland tree establishment; (2) the conditions conducive to effective natural regeneration need to be elucidated; (3) techniques for undergrowth establishment should be developed; (4) baseline ecological and floristic studies need expansion for certain plant communities and regions; (5) research is needed to deter-

mine if successful forest replacement will provide the functional services of the original ecosystem; and (6) the time is ripe for a coordinated southeastern regional monitoring effort. (See also W91-03244) (Author's abstract)
W91-03252

FRESHWATER MARSH CREATION AND RESTORATION IN THE SOUTHEAST.
Erwin (Kevin L.) Consulting Ecologist, Inc., Fort Myers, FL.
K. L. Erwin.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 233-265, 16 fig, 2 tab, 43 ref, append.

Descriptors: *Artificial wetlands, *Habitat restoration, *Marsh management, *Water resources management, *Wetland restoration, *Wetlands, Environmental impact, Monitoring, Planting management, Research priorities, Vegetation establishment, Water quality control, Water resources development.

Freshwater marsh habitat has been created or restored in the southeast to mitigate the environmental impacts associated with development activity and to provide enhancement of water quality. Key elements to successfully constructing a freshwater marsh system include: realistic goals and measurable success criteria; proper pre-construction design evaluation including a hydrological analysis; contour design; construction technique; proper water quality; compatibility of adjacent existing and future land uses; appropriate substrate characteristics; revegetation techniques; reintroduction of fauna; upland buffers and protective structures; supervision by an experienced professional; post-construction long-term management plan; and monitoring and reporting criteria. The monitoring required must be adequate in scope to determine the success or failure to meet project goals. A typical monitoring plan for a created freshwater marsh should include: (1) a post-construction, pre-planting survey of project contours and elevations; (2) ground and surface water elevation data collection; (3) water quality data collection; (4) biological monitoring including, but not limited to, fish and macroinvertebrate data collection; (5) evaluation of vegetation species diversity, percent cover, and frequency; and (6) wildlife utilization. Critical information gaps and research needs fall into the categories of site selection and design, project construction techniques, comparative studies of the biological communities and processes in created and natural systems, and the role of uplands and transitional habitats. (See also W91-03244) (Author's abstract)
W91-03253

RESTORATION AND CREATION OF PALUSTRINE WETLANDS ASSOCIATED WITH RIVERINE SYSTEMS OF THE GLACIATED NORTHEAST.
D. J. Lowry.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 267-280, 1 fig, 1 tab, 32 ref, append.

Descriptors: *Artificial wetlands, *Glaciation, *Habitat restoration, *Water resources management, *Wetland restoration, *Wetlands, Environmental policy, Environmental quality, Monitoring, Research priorities, Water resources development.

Published information on freshwater wetland creation in the glaciated northeastern United States is largely limited. Though there is more experience in constructing wetlands than the literature base would indicate, there has been no compilation of the experience obtained from most of the wetland creation projects in the region and there appears to be a general lack of detailed monitoring which would provide data necessary for assessment of results. Long-term, comprehensive studies evaluating the functions of created freshwater wetlands in the region are not presently being conducted. There is, therefore, a need to document the ability of such areas to provide a range of ecological and hydrological functions, rather than just serving as sites where wetland plants grow and that waterfowl visit. In evaluating future projects involving wetland creation as mitigation for wetland loss in the region, the following critical points should be emphasized: (1) the project proposal should provide an assessment of the wetland functions; (2) goals should be developed based on the most significant functions; (3) the hydrologic setting and water budget of the created area must be understood; (4) present capabilities to create other wetland types (swamps, fens, bogs) is in question; (5) every attempt should be made to replace lost wetland in the same hydrogeologic unit and reach of the riverine system associated with the original wetland; (6) an understanding of the area where the wetland is proposed to be created is needed; (7) detailed consideration of a number of logistical constraints (hydrologic controls, machinery needs, availability of plant stock and soils, sediment and erosion control, wildlife predation, and barriers to human intrusion) is always necessary; and (8) monitoring requirements should depend on the functions determined to be of most significance at the assessment stage. (See also W91-03244) (Fish-PTT)
W91-03254

REGIONAL ANALYSIS OF THE CREATION AND RESTORATION OF KETTLE AND POTHOLE WETLANDS.
G. G. Hollands.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 281-298, 40 ref, append.

Descriptors: *Artificial wetlands, *Environmental engineering, *Glaciation, *Hydrologic budget, *Water resources management, *Wetlands, Continental basins, Permeability, Potholes, Soil properties, Streams, Surface-groundwater relations, Water resources development, Watershed management.

Kettles are topographic basins created by a variety of glacial processes and occur randomly throughout glaciated regions. They are associated with both permeable and impermeable deposits. Kettle wetlands can have complex hydrologic types: those having no inlet or outlet streams, and those associated with surface water streams. Complex relationships of surface water, groundwater, water chemistry, and other hydrologic elements combine to create water balances. This has been documented in the Prairie Potholes region of the United States where site specific hydrologic research has been conducted. Creating kettle wetlands is similar to other types of freshwater wetland creation, except where unique vegetation and hydrology are involved and replication may be a complex, technical effort. Identification of limiting factors is critical to wetland creation. Typical factors important to kettle wetlands are: surface water hydrology, groundwater hydrology, stratigraphy, soils, and water chemistry. Depending upon the goals of the project, other limiting factors may include: nuisance animals, long-term maintenance/monitoring, lack of funds, and disposals of excavated soil. The primary concern in creating kettle wetlands is the establishment of the proper hydrology. This normally requires mid-course corrections in design during construction to establish proper post-construction hydrology. Critical needs include studies on microstratigraphy, geochemical processes, the properties of organic soil, and the details of hydrology. (See also W91-03244) (Author's abstract)
W91-03255

REGIONAL ANALYSIS OF FRINGE WETLANDS IN THE MIDWEST: CREATION AND RESTORATION.
Indiana Univ. at Bloomington. School of Public and Environmental Affairs.
D. A. Levine, and D. E. Willard.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 299-325, 4 tab, 85 ref, 2 append.

Descriptors: *Artificial wetlands, *Lake shores, *Reservoirs, *Water resources management, *Wetland restoration, *Wetlands, Monitoring, Plant populations, Planting management, Shoreline cover, Vegetation establishment, Water level fluctuations, Water resources development.

'Fringe' wetlands are those found along lakes and reservoirs, abundant in the midwest United States. Very few documented cases of fringe wetland mitigation are found. Their prevalence in this region suggests that Midwestern administrators of the regulatory program will be confronted with permits which impact fringe wetlands. Specific goals must be clearly outlined in the mitigation permit and include the following: detailed construction plans; a list of target species consistent with project goals; a long-term management plan; and a complete monitoring plan. To further ensure the success of mitigation, the following is recommended: the establishment of a fringe wetland should not be attempted where the fetch is greater than 13 km unless a dike is constructed to reduce wave action; and revegetation should utilize a combination of both natural (i.e., seed bank) and artificial (i.e., transplants) methods. Further research is needed (1) to determine how fringe wetland plant species and plant communities as a whole influence water quality, (2) to determine how water level fluctuations affect species composition and nutrient cycling in these wetlands, (3) to quantify shoreline stabilization needs and functions, and (4) to develop ecotypically-adapted planting stocks. (See also W91-03244) (Author's abstract)
W91-03256

CREATION AND RESTORATION OF RIPARIAN WETLANDS IN THE AGRICULTURAL MIDWEST.
Indiana Univ. at Bloomington. School of Public and Environmental Affairs.
D. E. Willard, V. M. Finn, D. A. Levine, and J. E. Klarquist.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 327-350, 1 fig, 1 tab, 35 ref, 2 append.

Descriptors: *Artificial wetlands, *Habitat restoration, *Riparian land, *Water resources management, *Wetland restoration, *Wetlands, Hydrologic budget, Planting management, Riparian vegetation, Riparian waters, Vegetation regrowth, Water resources development.

Effective restoration of riparian wetlands in the agricultural midwest region of the United States demands an early determination of project goals. There are no systematic records of the changes and developments that have occurred in and around several hundred large midwestern reservoirs with extensive wetland systems. Established goals will narrow the choices of potential project sites, which can then be evaluated based on hydrology, substrate, seedbank viability, and water quality. Creation and restoration plans should include a realistic timetable that accounts for construction and hydrology constraints, including specifications for revegetation species. Finally, plans should estimate long-term vegetation management requirements and establish monitoring schedules to assess project success. (See also W91-03244) (Fish-PTT)
W91-03257

CREATION AND RESTORATION OF RIPARIAN HABITAT IN SOUTHWESTERN ARID AND SEMI-ARID REGIONS.
SWCA, Inc., Tucson, AZ.
S. W. Carothers, G. S. Mills, and R. R. Johnson.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 351-366, 1 tab, 26 ref, 2 append.

Descriptors: *Artificial wetlands, *Habitat restoration, *Riparian land, *Water resources management, *Wetland restoration, *Wetlands, Arid lands, Planting management, Research priorities, Riparian vegetation, Riparian waters, Soil-water-plant relationships, Vegetation establishment, Water resources development.

Though the literature on characteristics, values, and functions of riparian habitats in the arid and semiarid southwestern region of the United States is fairly extensive, few papers that pertain to its creation or restoration are available. Because these projects are so recent, evaluations of successes and

failurcs are based on short-term results; long-term survival and growth rates are as yet unknown. In most cases, creation and restoration projects have involved the planting of vegetation and not the creation of conditions suitable for the natural regeneration of riparian habitats. Important considerations for riparian creation or restoration projects in the Southwest include: depth to water table; soil salinity and texture; amount and frequency of irrigation; effects of rising and dropping water tables on planted trees; protection from vandalism, off-road vehicles, and livestock; monitoring of growth rates as well as survival; and project design flexible enough to allow for major modifications. Because the creation and restoration of riparian habitats in the Southwest is new and mostly experimental, more information is needed for virtually every aspect of revegetation. Two major questions that need to be answered are whether planted trees survive for more than a few years and reach expected sizes, and what ranges of planting parameters are most cost-effective. Specific information needs include the identification of: the most suitable watering regimes; suitable soil conditions for various tree species; long-term survival and growth rates; and effects of variable water levels on planted trees. (See also W91-03244) (Author's abstract)
W91-03258

OVERVIEW AND FUTURE DIRECTIONS.
San Diego State Univ., CA. Pacific Estuarine Research Lab.
J. B. Zedler, and M. W. Weller.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 405-413, 1 fig, 1 ref.

Descriptors: *Artificial wetlands, *Habitat restoration, *Research priorities, *Water resources management, *Wetland restoration, *Wetlands, Decision making, Economic aspects, Environmental policy, Interagency cooperation, Water resources development.

Despite loss of over 50% of the wetlands in the contiguous United States, there is continuing pressure to use wetlands for immediate economic gain. Functional values that are nearly perpetual are rarely considered, and the complexity, integrity, and uniqueness of natural wetlands are undervalued. The greatest information and research strategies needed are: to improve wetland restoration/creation efforts, to determine the degree to which constructed systems can replace lost functions, and to determine the potential for persistence of restored and constructed wetlands. There is a national need to understand wetland functioning at its most basic and detailed levels, to compare natural and constructed wetlands within biogeographic regions, and to test methods of restoring wetlands using manipulative experimentation. Wetland research should be directed toward the proximate goal of preserving wetland values, and ultimately, of understanding the details of how wetlands function. Problems and objectives involve different research levels (e.g., size of areas, time scales, precision, and complexity). Some problems require immediate solutions for crisis situations; with answers based on research that uses a less precise level or a smaller size scale. The research program must build short-term goals into a long-term design, both to gain perspective and to prioritize projects and funding. Interaction between researchers and regulatory personnel will help solve practical problems and crisis decision-making and help develop technology for restoring degraded wetlands or constructing new ones. (See also W91-03244) (Fish-PTT)
W91-03260

WETLANDS RESTORATION/CREATION/ENHANCEMENT TERMINOLOGY: SUGGESTIONS FOR STANDARDIZATION.
Lewis Environmental Service, Inc., Tampa, FL.
R. R. Lewis.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 417-422, 12 ref.

Descriptors: *Artificial wetlands, *Publications, *Standards, *Water resources management, *Wetland restoration, *Wetlands, Environmental policy, Glossaries, Habitat restoration, Literature review, Water resources development.

A glossary has been prepared which attempts to bring some order to the terminology applied to the topic of wetland creation and restoration. Six glossaries applicable to the topic were reviewed and combined, with additional definitions from individual authors of published papers or proceedings, and regulatory or review agency rule promulgation. The five key definitions are: mitigation, restoration, creation, enhancement, and success. These terms are defined so that there is as little ambiguity and overlap as possible. A glossary definition and an explanation of each of the key terms is provided. (See also W91-03244) (Fish-PTT)
W91-03261

INFORMATION NEEDS IN THE PLANNING PROCESS FOR WETLAND CREATION AND RESTORATION.
For primary bibliographic entry see Field 2L.
W91-03262

WETLAND EVALUATION FOR RESTORATION AND CREATION.
Erwin (Kevin L.) Consulting Ecologist, Inc., Fort Myers, FL.
For primary bibliographic entry see Field 2L.
W91-03263

WETLAND DYNAMICS: CONSIDERATIONS FOR RESTORED AND CREATED WETLANDS.
Indiana Univ. at Bloomington. School of Public and Environmental Affairs.
For primary bibliographic entry see Field 2L.
W91-03264

RESTORATION OF THE PULSE CONTROL FUNCTION OF WETLANDS AND ITS RELATIONSHIP TO WATER QUALITY OBJECTIVES.
Butler Univ., Indianapolis, IN. Holcomb Research Inst.
O. L. Loucks.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 467-477, 4 fig, 3 tab, 19 ref.

Descriptors: *Hydrologic budget, *Rainfall-runoff relationships, *Water resources management, *Watershed management, *Wetland restoration, *Wetlands, Bed load, Headwaters, Hydrologic models, Land use, Model studies, Stream discharge, Streams, Water resources development.

Many wetlands and wetland restoration opportunities occur in the poorly drained headwaters of streams, along the stream floodplains, and at discharge points to larger water bodies. All of these are greatly changed by upland development that accelerates flows and increases the runoff pulse from headwater areas. Successful restoration must consider how the hydrologic pulse may have been changed and whether pulse control measures can bring stream flows within a range consistent with historical development of downstream wetlands. Comparison of spring versus summer loadings pulses indicates major differences in the seasonality of transport of excess nutrients into wetlands and downstream water bodies. The annual average loading is misleading, indicating that statements on wetland functions which ignore their role during pulsed events probably understate their significance. Modeling studies of runoff and sediment transport suggest the combination of reduced soil exposures and restoration of wetland cover in temporary detention areas can produce major benefits in stream water quality. With additional parameters, quantitative estimates could be made of the cumulative impact of wetland restoration toward mitigation of flood peaks and the transport of sediment and toxic substances into the adjacent aquatic systems. The general physical relationships between land use and hydrology provide only a guide to the prospective benefits associated with investment in wetland restoration. There is a need for more complete treatment-response modeling and model testing if the predictive capability needed to improve wetland restoration is to become available. (See also W91-03244) (Author's abstract)
W91-03265

VEGETATION DYNAMICS IN RELATION TO WETLAND CREATION.
Connecticut Coll., New London.
For primary bibliographic entry see Field 2I.
W91-03266

LONG-TERM EVALUATION OF WETLAND CREATION PROJECTS.
Hampshire Coll., Amherst, MA. School of Natural Science.
C. D'Avanzo.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 487-496, 42 ref.

Descriptors: *Artificial wetlands, *Long-term planning, *Management planning, *Performance evaluation, *Water resources management, *Wetland restoration, *Wetlands, Environmental engineering, Evaluation, Habitat restoration, Soil properties, Succession, Vegetation establishment, Water resources development.

The long-term evaluation of artificial wetlands is very difficult because wetlands are created for a variety of purposes. Little is known about basic aspects of many wetland systems, 'succession' in wetlands is less straightforward than previously assumed, and it is difficult to generalize from one wetland type to another. There is a striking range of opinions about the success of wetlands that have been created. On the one hand, the U.S. Army Corps of Engineers' dredged material stabilization program exemplifies artificial wetland projects that appear successful over a decade or more. Several types of criteria including vegetation characteristics, soil chemistry, and animal studies suggest that several dredged material wetlands are becoming similar to reference wetlands with time. But some wetlands characteristics (soil carbon) may require many years to reach natural levels. In contrast, a great many other artificial wetland projects are problematic or failures, because of improper hydrology, erosion, herbivory, and invasion by upland plants. Many projects have never been evaluated so their permanence is not known. In evaluating projects with regard to persistence of the created wetlands, the following points are especially important: (1) evaluations over at least 10-20 years are desirable; (2) vegetation characteristics are useful but do not necessarily indicate function; (3) chemical/physical aspects of wetland soils are also useful in evaluating trends; (4) local reference wetlands are critical for comparative purposes; and (5) some wetlands should be created with great caution because they have failed in the past or because very little is known about these wetland types. (See also W91-03244) (Author's abstract)
W91-03267

REGIONAL ASPECTS OF WETLANDS RESTORATION AND ENHANCEMENT IN THE URBAN WATERFRONT ENVIRONMENT.
Rosenstiel School of Marine and Atmospheric Science, Miami, FL.
For primary bibliographic entry see Field 4C.
W91-03268

WATERFOWL MANAGEMENT TECHNIQUES FOR WETLAND ENHANCEMENT, RESTORATION AND CREATION USEFUL IN MITIGATION PROCEDURES.
Texas A and M Univ., College Station. Dept. of Wildlife and Fisheries Sciences.
For primary bibliographic entry see Field 2L.
W91-03269

MITIGATION AND THE SECTION 404 PROGRAM: A PERSPECTIVE.
Environmental Protection Agency, Atlanta, GA.

Region IV.
For primary bibliographic entry see Field 6E.
W91-03271

OPTIONS TO BE CONSIDERED IN PREPARATION AND EVALUATION OF MITIGATION PLANS.
Environmental Protection Agency, Atlanta, GA. Region IV.
For primary bibliographic entry see Field 6B.
W91-03272

PHOTOHETEROTROPHY AND DARK HETEROTROPHY IN ICE-COVERED LAKE ST. CLAIR.
Windsor Univ. (Ontario). Great Lakes Inst.
D. G. Wallen.
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 3, p 339-345, 1990. 3 fig, 1 tab, 46 ref.

Descriptors: *Carbon, *Glucose, *Great Lakes, *Ice cover, *Iced lakes, *Lake St Clair, *Lakes, *Limnology, *Photosynthesis, *Phytoplankton, Aphotic zone, Euphotic zone, Light intensity, Primary productivity.

Both light and dark uptake of glucose carbon by the microplankton in ice-covered Lake St. Clair were measured several times over the winter period, from December to March. Heterotrophic potentials (Vmax) were consistently and significantly higher in the light (ranging from 3.9-10.7 nanomoles glucose/L/hr) than in the dark (2.5-5.2 nM glucose/L/hr). Respiratory release of glucose carbon ranged from 0.27 to 2.28 times higher in the dark than light. Vertical profiles of photosynthesis and heterotrophy on 21 January and 20 February indicated that photoheterotrophic carbon uptake ranged from 8% of photosynthetic assimilation just below the ice to 60% in the lower euphotic zone, ranging from 125.0-158.3 and 90.6-298.1 ng C/L/hr on 21 January and 20 February, respectively. Dark uptake in the aphotic zone ranged from 87.5-133.3 and 99.9-257.3 nanograms C/L/hr on 21 January and 20 February, respectively. Total assimilation of glucose carbon in the water column ranged from 29% to 36% of total carbon assimilated photosynthetically. Under the harsh winter conditions of low irradiation and temperature the mechanisms of photoheterotrophy and dark heterotrophy may be ecologically important in augmenting reduced photosynthetic production. (Author's abstract)
W91-03399

DYNAMICS OF THE BYTHOTREPHES INVASION OF THE ST. LAWRENCE GREAT LAKES.
Erindale Coll., Mississauga (Ontario). Dept. of Zoology.
W. G. Sprules, H. P. Riessen, and E. H. Jin.
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 3, p 346-351, 1990. 2 fig, 2 tab, 28 ref.

Descriptors: *Great Lakes, *Introduced species, *Limnology, *Waterfleas, *Zooplankton, Lake Michigan, Population dynamics, Spatial distribution.

Bythotrephes cederstroemii, a predatory planktonic cladoceran, has recently invaded the St. Lawrence Great Lakes from its native Eurasia. The species was probably transported in the ballast water of ships returning from a port such as Leningrad to take on cargo in the Great Lakes. Life history analyses of Bythrotrephes suggest that the invasion probably took place during the late 1970s or early 1980s when shipping traffic to the Great Lakes reached an all-time peak. This introduced cladoceran is highly vulnerable to fish predation due to its large size and prominent eye. B. cederstroemii has already reached densities in Lake Michigan typical of its native lakes. The feeding rates of B. cederstroemii are low compared to the reproductive potential of its plankton prey. Density and feeding rate data for Bythotrephes indicate that it is unlikely to have major impacts on prey populations in the Great Lakes. (Geiger-PTT)
W91-03400

FLOW DISTRIBUTION IN THE ST. LAWRENCE RIVER SYSTEM AT WOLFE ISLAND, KINGSTON BASIN, LAKE ONTARIO.
McMaster Univ., Hamilton (Ontario). Dept. of Civil Engineering and Engineering Mechanics.
For primary bibliographic entry see Field 2E.
W91-03401

EVALUATION OF SEDIMENT TRAPS IN LAKE ST. CLAIR, LAKE ONTARIO, AND HAMILTON HARBOUR.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
F. M. Boyce, P. F. Hamblin, D. G. Robertson, and F. Chiocchio.
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 3, p 366-379, 1990. 7 fig, 5 tab, 15 ref.

Descriptors: *Lake Ontario, *Lake St Clair, *Lake sediments, *Limnology, *Sampling, *Sediment sampler, *Suspended sediments, *Trap efficiency.

The five-chamber version of the Kenney sediment sampler and conventional sediment bottle traps with port diameters of 5, 10 and 15 mm were studied for their ability to sample suspended sediments in shallow, wave-dominated waters in Lake St. Clair, Lake Ontario, and Hamilton Harbor. The catch rates of the horizontally-ported chambers of the Kenney sampler correlated strongly and positively with the root mean square horizontal flow velocity over the trapping interval. A similar dependence was suspected for the settling tubes. There was no strong tendency for the traps tested to sort the sediment differentially; the catch rate was mainly controlled by hydrodynamic effects. The catch rates for the Kenney sampler and the bottle traps were strongly velocity dependent at Reynolds numbers (based on overall trap diameter) up to 10,000 and possibly beyond indicating boundary layer and wake effects at the trap itself. Until a more thorough investigation is made of the effects of horizontal velocity (both steady and oscillating) on all types of sediment traps, it is suggested that sediment traps in moving water be used primarily for qualitative analysis. (Geiger-PTT)
W91-03402

SUDDEN, EXTREME LAKE ERIE STORM SURGES AND THE INTERACTION OF WIND STRESS, RESONANCE, AND GEOMETRY.
Ohio State Univ., Columbus. Dept. of Civil Engineering.
C. Libicki, and K. W. Bedford.
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 3, p 380-395, 1990. 10 fig, 8 tab, 15 ref. NOAA, Ohio Sea Grant Contract NA79AA-D-00120 and NA80AA-D-0100.

Descriptors: *Lake Erie, *Limnology, *Model studies, *Resonance, *Seiches, *Storm surges, *Wind-driven currents, Friction, Simulation analysis, Topography, Water depth.

Wind-generated surges on Lake Erie are modeled in an attempt to explain their behavior and describe the influence of such factors as non-linear resonance dynamics, planform geometry, bottom topography, and friction on surge development, climax, and dissipation. The maximum surge was typically associated with the first characteristic to spend its entire transit beneath the wind stress. In the idealized case (flat, rectangular basin, no friction), surge height increased with stress band propagation speed until reaching a plateau at resonance. The chief effect upon the main surge of including the nonlinear term (at typical and stress values) is to decrease the surge height and time of arrival by approximately the same fraction. The inclusion of variable bottom topography generally exaggerated the surge height in basins that shallow from upwind to downwind and diminished surge height in the reverse case. Friction diminished surge heights and thickened the shock transition region. The large role played by frictional losses in storms progressing from northeast to southwest indicated the importance of properly accounting for these and other losses, such as nonreflective boundaries, in this type of storm. Variable width can serve to focus and thereby exaggerate surge heights by 40 to 50%. This exaggeration was especially pronounced at resonance at the Buffalo end of the lake. The criteria for resonance are fairly strict: a sharp wind front that remains intact for most of the length of the lake, wind and propagation velocities that are aligned with the lake axis, and a propagation speed that closely matches the free gravity wave speed. Since most destructive storms do not meet these criteria so that resonance is not a major contributing factor. (Author's abstract)
W91-03403

HISTORICAL VARIATION OF WATER LEVELS IN LAKES ERIE AND MICHIGAN-HURON.
National Water Research Inst., Burlington (Ontario). Research and Applications Branch.
C. T. Bishop.
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 3, p 406-425, 1990. 9 fig, 3 tab, 56 ref.

Descriptors: *Great Lakes, *Lake Erie, *Lake Huron, *Lake Michigan, *Limnology, *Paleohydrology, *Paleolimnology, *Water level fluctuations, Archaeology, Climatic changes, Dredging, High water mark, History, Stratigraphy.

The earliest reliable water level measurements for Lakes Erie and Michigan-Huron (these two lakes behave the same limnologically) recorded in 1819 showed record low water levels. These early measurements are compared with the modern data set beginning in 1860. Historical and archeological evidence at European settlements on the Great Lakes from the early 17th century sheds light on the water level history of these lakes prior to 1819. Rates of isostatic rebound are generally believed to be decreasing exponentially with time. Stratigraphic evidence from Lake Michigan-Huron over the past 1,800 yr is interpreted to deduce water levels over this time period. When the effects on the lake levels of isostatic rebound and man-made channel changes (dredging) were examined, it was concluded that, over at least the last 1,800 yr, climate-related variations in maximum mean annual water levels have probably not exceeded those measured on Lakes Erie and Michigan-Huron since A.D. 1819. (Author's abstract)
W91-03405

DETERMINATION OF AVAILABLE SUBSURFACE LIGHT FOR PHOTOCHEMICAL AND PHOTOBIOLOGICAL ACTIVITY.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
J. H. Jerome, R. P. Bukata, and J. E. Bruton.
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 3, p 436-443, 1990. 6 fig, 1 tab, 6 ref.

Descriptors: *Irradiation, *Light intensity, *Light penetration, *Limnology, Downwelling, Mathematical equations.

Appropriate determinations of available subsurface light for photochemical and photobiological processes require accurate estimates of the subsurface scalar irradiation. Quite often only values of downwelling irradiation are available. Therefore, two sets of multiplicative factors were derived. The first set converts a daily irradiation just above the surface into a daily scalar irradiation just below the surface. The second set converts an 'effective' (i.e., depth-averaged) daily irradiation for a specific photic zone into an 'effective' daily scalar irradiation for that photic zone. These multiplicative factors are presented as functions of the subsurface volume reflectance of the water for the volume reflectance range 0.0 to 0.14. For a latitude range appropriate to the Great Lakes, these multiplicative factors vary between 1.1 and 2.1. (Author's abstract)
W91-03407

QUANTITATIVE MODEL OF THE DISPERSAL OF DETRITAL INPUTS AND MINOR COMPOSITIONAL COMPONENTS IN LAKE MICHIGAN SEDIMENTS.
Michigan Univ., Ann Arbor. Dept. of Geological Sciences.
A. R. B. Zimmerman, and R. M. Owen.

Journal of Great Lakes Research JGLRDE, Vol. 16, No. 3, p 444-456, 1990. 9 fig, 4 tab, 58 ref. NOAA Sea Grant NA86AA-D-SG043.

Descriptors: *Detritus, *Great Lakes, *Lake Michigan, *Lake sediments, *Limnology, *Mathematical models, *Model studies, *Sediment transport, Carbonates, Manganese, Particle size, Sediment erosion.

Mathematical models were developed to ascertain the sources, distribution, and fate of sedimentary material entering Lake Michigan. Major compositional end-members were identified by a modified Q-mode factor analysis procedure, and estimates of the relative amount of each end-member in each sample were obtained by linear programming. Four factors account for 93.8% of the total variance. These are interpreted as representing the inputs of fine-grained (Factor 1), and coarse-grained (Factor 2) detrital minerals, manganous carbonate (Factor 3) and non-manganous carbonate (Factor 4) to the lake sediment. Significant linear correlations between the relative amount of each compositional end-member and the grain-size distribution for each sample support these interpretations. Contour plots of end-member distributions suggest that the sediment chemistry of Lake Michigan is primarily influenced by regional-scale physical processes. In a revised version of the model, the distribution of minor sediment components (ferromanganese oxyhydroxides and siliceous plankton tests) were examined. Each model accounted for approximately 90% of the measured elemental concentrations in lake sediment. This modeling approach is a viable method for determining the distribution of sedimentary inputs in large lacustrine basins, and may also be useful in monitoring the dispersal pathways of coastal erosion products or chemical pollutants. (Author's abstract)
W91-03408

MONITORING RIVER PLUME TRANSPORT AND MESOSCALE CIRCULATION IN GREEN BAY, LAKE MICHIGAN, THROUGH SATELLITE REMOTE SENSING.
Wisconsin Univ.-Madison. Environmental Remote Sensing Center.
For primary bibliographic entry see Field 5B.
W91-03410

ROOT AERENCHYMA, OXYGEN LEAKAGE PATTERNS AND ALCOHOLIC FERMENTATION ABILITY OF THE ROOTS OF SOME NYMPHAEID AND ISOETID MACROPHYTES IN RELATION TO THE SEDIMENT TYPE OF THEIR HABITAT.
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
For primary bibliographic entry see Field 2I.
W91-03414

ADAPTATIONS TO FLOODING IN PLANTS FROM RIVER AREAS.
Katholieke Univ. Nijmegen (Netherlands). Dept. of Experimental Botany.
For primary bibliographic entry see Field 2I.
W91-03415

ECOPHYSIOLOGY OF PLANTS IN WATERLOGGED AND FLOODED ENVIRONMENTS.
Vrije Univ., Amsterdam (Netherlands). Dept. of Ecology and Ecotoxicology.
For primary bibliographic entry see Field 2I.
W91-03416

GENETIC VARIATION AND ADAPTATION TO FLOODING IN PLANTS.
University of East Anglia, Norwich (England). School of Biological Sciences.
For primary bibliographic entry see Field 2I.
W91-03417

LARGE SPATIAL AND TEMPORAL BIOLOGICAL VARIABILITY OF INDIAN RIVER LAGOON.
Saint Johns River Water Management District, Palatka, FL.
R. W. Virnstein.
Florida Scientist FLSCAQ, Vol. 53, No. 3, p 249-256, Summer 1990. 2 fig, 26 ref.

Descriptors: *Biological properties, *Ecology, *Ecosystems, *Florida, *Habitats, *Indian River Lagoon, *Lagoons, *Species composition, Biological samples, Population density, Sampling, Seasonal variation, Spatial distribution, Species diversity, Temporal distribution, Variability.

A large biological variability exists in the Indian River lagoon system, both in spatial and temporal dimensions. Biotic communities in the northern end of the lagoon are temperate, whereas those in the southern part of the lagoon are tropical, e.g. Spartina marshes dominate in the north and mangrove forests and seagrass in the south. The fish fauna of the northern part of the lagoon system is strikingly depauperate when compared to that of the south. Over distances of only a few kilometers or even meters, species composition can change substantially, and densities can vary by two or three orders of magnitude. The lagoon of a few centuries ago was quite different from the lagoon of today. Large changes in submerged vegetation have occurred within the last decade. Changes between years often far exceed and, thus, obscure seasonal patterns. In the same habitat, day-to-day variation in samples collected may be large. Temporal and spatial variability can be used to identify the processes that produce the variability. It is concluded that a representative site or time period does not exist; therefore a sampling program for the Indian River lagoon must reflect the diversity of the system. (Author's abstract)
W91-03443

NITROGEN METABOLISM IN THE BRACKISH LAKE NAKANOUMI: IV. SEASONAL VARIATION OF NITRATE NITROGEN.
Shimane Univ., Matsue (Japan). Environmental Science Lab.
Y. Seike, K. Kondo, H. Hashitani, M. Okumura, and K. Fujinaga.
Japanese Journal of Limnology RIZAAU, Vol. 51, No. 3, p 137-147, 1990. 8 fig, 5 tab, 22 ref.

Descriptors: *Brackish water, *Chlorine, *Lake Nakanoumi, *Lakes, *Limnology, *Nitrates, *Nitrogen cycle, *Saline lakes, *Water chemistry, Japan, Nutrients, Rainfall, Seasonal variation, Snowmelt, Surface water.

The seasonal variation of nitrate in the upper layer in the brackish Lake Nakanoumi was investigated by the analysis of data collected monthly during the period of 1976-1986. Upward trends in nitrate concentration were found in the colder season (January to March), and also in the rainy season (July). In contrast to nitrate, chlorine levels decreased at the same time. A significant negative correlation between nitrate concentration and chlorine concentration in the surface water in Lake Nakanoumi was found in January, February, March and July. In addition, from the analysis of the correlation between the increment of nitrate concentration in the surface water and cumulative rainfall, it was concluded that the accumulation of nitrate in the upper layer is mainly caused by discharge from the rivers into the lake through rainfall and melted snow. (See also W89-00769) (Author's abstract)
W91-03452

SIGNIFICANCE OF LOW-OXYGEN ZONE FOR NITROGEN CYCLING IN A FRESHWATER LAKE: PRODUCTION OF N2O BY SIMULTANEOUS DENITRIFICATION AND NITRIFICATION.
Nagoya Univ. (Japan). Water Research Inst.
M. Yoh, A. Yagi, and H. Terai.
Japanese Journal of Limnology RIZAAU, Vol. 51, No. 3, p 163-171, 1990. 4 fig, 27 ref.

Descriptors: *Cycling nutrients, *Denitrification, *Lakes, *Limnology, *Nitrification, *Nitrogen cycle, Ammonium, Japan, Lake Kizake, Nitrogen, Oxygen depletion.

Denitrifying and nitrifying activities were determined to elucidate the mechanism of nitrous oxide accumulation in the oxygen-depleted zone of Lake Kizake. Both activities were detected without any substrate enrichments in a zone of low-oxygen content (0.03-0.14 ml/L), where nitrous oxide and nitrite had accumulated. The measured nitrifying activity roughly coincided with the ammonium utilization estimated from the ammonium budget in this zone during the observation period. On the basis of these activities and the change in nitrous oxide concentration, it was suggested that the observed nitrous oxide accumulation had dual origins of nitrification and denitrification and that these productions were in dynamic equilibrium with further reduction of nitrous oxide to nitrogen. The low-oxygen zone was found to be an active site for nitrogen cycling and was characterized by the presence of dissolved Mn and the absence of dissolved Fe and sulfide. (Author's abstract)
W91-03453

RELATIONSHIPS BETWEEN PHYTOPLANKTON OCCURRENCE AND SALINITY OR WATER TEMPERATURE IN BRACKISH LAKE NAKANOUMI, 1979-1986.
Shimane Univ., Matsue (Japan). Environmental Science Lab.
K. Kondo, Y. Seike, and Y. Date.
Japanese Journal of Limnology RIZAAU, Vol. 51, No. 3, p 173-184, 1990. 7 fig, 4 tab, 16 ref.

Descriptors: *Lake Nakanoumi, *Limnology, *Phytoplankton, *Saline lakes, *Salinity, *Species composition, *Water temperature, Algal blooms, Brackish water, Japan, Lagoons, Lakes.

The relationships between the occurrence of phytoplankton and salinity or water temperature were investigated for 8 years from 1979 to 1986 in brackish Lake Nakanoumi. Fourteen species such as Skeletonema costatum, Prorocentrum minimum, and Cyclotella nana were dominant in this lake. Five among the 14 species bloomed in conditions of water temperature less than optimal for their growth, whereas every species bloomed in optimum salinity conditions. These observations indicated that the occurrence of dominant phytoplankton species in the lake is more strongly controlled by salinity than by water temperature. A correlation between nutrient concentrations and phytoplankton blooms was not observed in Lake Nakanoumi. The result of a comparison of weighted mean value of water temperature and salinity for the two periods of 1974-1978 and 1979-1986 also indicated the greater importance of salinity than water temperature in the occurrence of phytoplankton blooms in Lake Nakanoumi. (Author's abstract)
W91-03455

SESTONIC C:N:P RATIOS IN THE SOUTH BASIN OF LAKE BIWA WITH SPECIAL ATTENTION TO NUTRITIONAL STATE OF PHYTOPLANKTON.
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
M. Nakanishi, O. Mitamura, and T. Matsubara.
Japanese Journal of Limnology RIZAAU, Vol. 51, No. 3, p 185-189, 1990. 3 fig, 1 tab, 17 ref.

Descriptors: *Japan, *Lake Biwa, *Lakes, *Limiting nutrients, *Limnology, *Nutrient concentrations, *Phytoplankton, Carbon, Nitrogen, Nutrient deficiency, Particulate matter, Phosphorous, Seasonal variation.

To estimate seasonal change in the nutritional state of phytoplankton in the south basin of Lake Biwa, surveys for the determination of particulate C:N:P ratios were conducted at five stations from May 1987 to May 1988. Levels of particulate carbon (PC), particulate nitrogen (PN) and particulate phosphorous (PP) varied in the ranges of 20-210, 3-32, and 0.13-1.09 micromol/L, respectively. Seasonal changes in PC:PN ratio were relatively constant at all stations except for October and/or November when the ratio exceeded 10. On the other hand, the PC:PP ratio often showed extraordinarily high values from May to mid-October.

The seasonal pattern of PN:PP ratio was similar to that observed for PC:PP ratio. The particulate C:N:P ratios indicated the possibility that phytoplankton were exposed frequently to moderate or severe phosphorous deficiency from May to October 1987, but little thereafter until May 1988, whereas they were not in the state of severe nitrogen deficiency except for a given time in November of 1987. (MacKeen-PTT)
W91-03456

RELATIONSHIP BETWEEN THE YEARLY CHANGES IN PHYTOPLANKTON OCCURRENCE AND NUTRIENT CONCENTRATION IN BRACKISH LAKE NAKANOUMI, 1974-1986.
Shimane Univ., Matsue (Japan). Environmental Science Lab.
For primary bibliographic entry see Field 5C.
W91-03457

DETERMINATION OF GOLD IN NATURAL WATERS BY NEUTRON ACTIVATION AND GAMMA-SPECTROMETRY AFTER PRECONCENTRATION WITH TRIBUTYL PHOSPHATE AS SOLID EXTRACTANT.
Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions.
For primary bibliographic entry see Field 2K.
W91-03463

SANITARY AND BACTERIAL ANALYSIS OF WATER AND BOTTOM SEDIMENTS OF A HEAVILY POLLUTED, HYPERTROPHIC LAKE.
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Dept. of Ecology and Freshwater Biology.
For primary bibliographic entry see Field 5B.
W91-03476

MACROFAUNA OF ELODEIDS OF TWO LAKES OF DIFFERENT TROPHY. I. RELATIONSHIPS BETWEEN PLANTS AND STRUCTURE OF FAUNA COLONIZING THEM.
Akademia Rolnicza, Lublin (Poland). Dept. of Zoology and Hydrobiology.
R. Kornijow.
Ekologia Polska ELPLBS, Vol. 37, No. 1/2, p 31-48, 1989. 4 fig, 3 tab, 48 ref.

Descriptors: *Aquatic animals, *Eutrophic lakes, *Limnology, *Macrophytes, *Mesotrophic lakes, *Waterweeds, Aquatic biota, Aquatic plants, Biomass, Ecosystems, Lake Glebokie, Lake Piaseczno, Poland, Species composition, Species diversity.

Very little is known about the influence of lake fertility upon the relationships between macrohydrophytes and the species composition and abundance of fauna colonizing them. The composition and abundance of macrofauna living on elodeid species and how those elodeid species differ in habitat and life cycle was determined then evaluated for different environmental conditions at various stages of lake eutrophication. Studies were conducted between January 1983 and December 1984 in the eutrophic Lake Glebokie and mesotrophic Lake Piaseczno, Poland. Macrofauna colonizing six elodeid species were analyzed (Myriophyllum alternifolium DC., M. spicatum L., Ceratophyllum demersum L., Potamogeton praelongus Wulfen, P. Lucens L., and Elodia canadensis Rich). The preference of several fauna taxons for specific groups of elodeids varied with composition and degree of species diversity and by dominance structure. Greater differences in fauna density and biomass were observed in relation to fresh plant weight. Values were inversely proportional to plant biomass and to density and biomass of fauna, as they relate to bottom surface. These relationships were probably connected with the possibility of using food resources of a given habitat by invertebrates. The higher trophy in Lake Glebokie was reflected by poorer and slightly different quantitative composition, by smaller total species diversity and differently formed dominance structure, higher density and biomass of fauna as related to fresh plant weight and bottom surface, than in Lake Piaseczno. (See also W91-03478) (Mertz-PTT)
W91-03477

MACROFAUNA OF ELODEIDS OF TWO LAKES OF DIFFERENT TROPHY. II. DISTRIBUTION OF FAUNA LIVING ON PLANTS IN THE LITTORAL OF LAKES.
Akademia Rolnicza, Lublin (Poland). Dept. of Zoology and Hydrobiology.
R. Kornijow.
Ekologia Polska ELPLBS, Vol. 37, No. 1/2, p 49-57, 1989. 3 fig, 1 tab, 20 ref.

Descriptors: *Aquatic fauna, *Eutrophic lakes, *Limnology, *Macrophytes, *Mesotrophic lakes, *Poland, Aquatic biota, Biomass, Ecological effects, Hornwort, Invertebrates, Mesotrophy, Pondweeds, Species composition, Species diversity, Water depth, Water milfoil.

The horizontal distribution of fauna living on aquatic macrophytes is not well known, and very little information exists concerning the relationship between the depth at which plants grow and the qualitative and quantitative composition of invertebrates colonizing them. Studies were conducted on the occurrence of invertebrate fauna colonizing Myriophyllum alternifolium D.C., Ceratophyllum demersum L. and Potamogeton lucens L. in different types of littoral and at different depths. Mesotrophic Lake Piaseczno and eutrophic Lake Gleobkie, Poland were examined. Differences between the fauna colonizing different types of shore in the mesotrophic lake concerned mainly its species composition and dominance structure. In the eutrophic lake, its density and biomass caused the main differences between fauna, especially in relation to the bottom surface. The influence of depth on invertebrates was reflected mainly by their species composition and dominance structure, and was very distinct in the eutrophic lake. Species abundance was found to decrease with increasing depth. (See also W91-03477) (Mertz-PTT)
W91-03478

CORRELATION BETWEEN BIOMASS, CHLOROPHYLL-A, PHOTOSYNTHESIS AND PHYTOPLANKTON STRUCTURE IN A LAKE.
Akademia Rolnicza, Lublin (Poland). Inst. of Natural Foundations of Plant Production.
W. Wojciechowska.
Ekologia Polska ELPLBS, Vol. 37, No. 1/2, p 59-82, 1989. 10 fig, 4 tab, 33 ref.

Descriptors: *Chlorophyll, *Eutrophic lakes, *Lake Bikeze, *Limnology, *Phytoplankton, *Primary productivity, Biomass, Chlorophyll a, Fluctuations, Photosynthesis, Poland, Productivity, Species composition.

The relationship between phytoplankton biomass, chlorophyll concentration and primary production was investigated over one growing season (April-November) in 16 series, with each series lasting 3 consecutive days. Measurements were taken in shallow (3 m) eutrophic Lake Bikcze, Poland. Biomass, chlorophyll-a concentration and primary production were measured every day. No unequivocal correlation between the three parameters was found. The proportion of chlorophyll-a in phytoplankton biomass varied with phytoplankton structure, cell age and light . Daily variations in phytoplankton populations structures were found, with photosynthesis being limited by light, depending on phytoplankton structure. Ecological studies of phytoplankton are necessary to determine the taxonomic composition and dominance structure of the community studied. (Mertz-PTT)
W91-03479

HABITAT DIVERSITY AND FISH REPRODUCTIVE FUNCTION OF FLOODPLAIN ECOSYSTEMS.
Lyon-1 Univ., Villeurbanne (France). Lab. d'Ecologie des Eaux Douces.
G. H. Copp.
Environmental Biology of Fishes EBFID3, Vol. 26, No. 1, p 1-27, September 1989. 7 fig, 6 tab, 106 ref.

Descriptors: *Aquatic habitats, *Ecosystems, *Fish populations, *Flood plains, *Limnology, *Spawning, Biomass, Braided streams, Geomorphology, Hydrological regime, Introduced species, Lentic environment, Lotic environment, Meanders, Multivariate analysis, Sampling, Succession.

Fish reproduction in flood plain ecosystems, based on relative abundance and total biomass of 0+ juveniles, was studied using the synchronic approach to typological analysis in conjunction with Point Abundance Sampling by modified electrofishing. In three different flood plains of the Upper Rhone River, 1015 point samples yielding 4573 juveniles (0+) from 21 species were collected from 48 ecosystems of various geomorphological origin. The results demonstrate the lotic-to-lentic succession of flood plain ecosystems to be a series of nonsequential reproductive zones, with spawning conditions being reflected by the specific composition and guild structure of the young-of-the-year (YOY) fish assemblages. The habitat diversity and the fish reproductive potential of flood plain ecosystems are strongly influenced by geomorphological origin and by past and present hydrological conditions. The YOY assemblages of autogenically driven ecosystems (usually of anastomose or meander origin) tend to differ both in composition and in quantity from those found in allogenically driven ecosystems (generally of braided origin). Ecosystems of intermediate character, and fish reproduction thereof, occur as the result of either ecosystem rejuvenation or senescence: autogenically driven ecosystems by allogenic mechanisms, or allogenically driven ecosystems at similar and at different successional status, the flood plain as an entity is seen as 'stable' with respect to fish reproduction. (Author's abstract)
W91-03482

GULL CONTRIBUTIONS OF PHOSPHORUS AND NITROGEN TO A CAPE COD KETTLE POND.
Cape Cod National Seashore, South Wellfleet, MA.
For primary bibliographic entry see Field 5B.
W91-03484

DOWNSTREAM EFFECTS OF IMPOUNDMENTS ON THE WATER CHEMISTRY OF THE BUFFALO RIVER (EASTERN CAPE), SOUTH AFRICA.
Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
R. W. Palmer, and J. H. O'Keefe.
Hydrobiologia HYDRB8, Vol. 202, No. 1/2, p 71-83, August 29, 1990. 5 fig, 3 tab, 44 ref.

Descriptors: *Dam effects, *Reservoirs, *South Africa, *Water chemistry, *Water quality, Agricultural runoff, Dams, Hydrological regime, Low flow, Nitrates, River flow, River systems, Water pollution effects.

Dams are physical barriers in river systems, and they and their associated impoundment water can result in changes to the natural flow regime, water temperature, sediment loads, and chemistry of the receiving river. The downstream effects of impoundments on the chemistry of pristine and polluted stretches of the Buffalo River were investigated in the context of the Serial Discontinuity Concept (SDC), which proposes that dams act as disruptions to the natural continuum of hydrological, physico-chemical, and biotic changes down an impounded river. Impoundments which received water from a near-pristine upper catchment caused alterations of the water quality which were consistent with the SDC, and recovery to riverine conditions was within 2.6 to 18.4 km of the dam, depending on flow. Impoundments which received agricultural runoff and urban effluents generally caused an improvement in the water quality of the downstream reaches (with the exception of nitrate concentrations, which were higher in the tailwaters compared to inflowing water). Impoundments with polluted inflows therefore usually 'reset' the river towards its natural condition, rather than acting as perturbations. This represents a reversal of the SDC described for pristine rivers. The downstream effects of impoundments on water chemistry therefore depend on the relative

impact of other catchment perturbations. These disturbances become more severe during low flow, and it is during this time that the impoundments have the greatest effect on the river. (Author's abstract)
W91-03485

EFFECTS OF ANABAENA FLOS-AQUAE INOCULATION, PH ELEVATION, AND N/P MANIPULATION ON THE ALGAL BIOMASS AND SPECIES COMPOSITION OF AN ACID LAKE.
West Virginia Univ., Morgantown. Dept. of Biology.
G. R. Wilcox, and J. DeCosta.
Hydrobiologia HYDRB8, Vol. 202, No. 1/2, p 85-104, August 29, 1990. 10 fig, 15 tab, 27 ref.

Descriptors: *Acid lakes, *Algae, *Algal growth, *Anabaena, *Cyanophyta, *Hydrogen ion concentration, *Limnology, *Nutrient concentrations, *Population dynamics, *West Virginia, Biomass, Limiting nutrients, Nitrates, Phosphorus, Species composition.

The mechanisms by which blue-green algae become dominant in lakes has been a formidable problem generating a vast number of observations and a variety of hypotheses. Three bag experiments were performed in an acidic lake, Cheat Lake, West Virginia, to determine if an inoculation of the blue-green alga, Anabaena flos-aquae, could be maintained in: (1) acid environments in which the nitrate nitrogen:total phosphorus ratio was manipulated above and below 5; (2) environments in which the pH of the acid lake water was increased to pH 7 or 8, and the nitrate nitrogen:total phosphorus ratio was manipulated above and below 5; and (3) environments in which pH was increased to 7, and 10 micrograms/L phosphorus was added alone and in combination with 70 micrograms/L nitrogen. Algal biomass increased as the concentration of total phosphorus increased in the various treatments. Increased pH treatments with phosphorus addition displayed an initial lag in algal growth of 2 to 6 days followed by intense growth. Analysis of the species composition of the various treatments indicated that increasing pH and adding phosphorus or manipulating the nitrate nitrogen:total phosphorus ratio to less than 5 did not favor blue-green algal growth. These data suggest that the Anabaena flos-aquae inoculated was replaced by the indigenous algae in the environments provided. (Fish-PTT)
W91-03486

ALLOCHTHONOUS INPUT AND RETENTION IN A SMALL MOUNTAIN STREAM, SOUTH AFRICA.
Cape Town Univ. (South Africa). Dept. of Zoology.
B. A. Stewart, and B. R. Davies.
Hydrobiologia HYDRB8, Vol. 202, No. 3, p 135-146, August 31, 1990. 4 fig, 5 tab, 37 ref.

Descriptors: *Leaves, *Litter, *Mountain streams, *Nutrient transport, *Organic matter, *South Africa, *Stream ecology, Detritus, Low flow, River sediments, Seasonal variation, Stream order.

Allochthonous material entering small streams represents the primary energy base available to consumers in these systems. Allochthonous input and benthic coarse particulate organic matter (CPOM) standing stocks were investigated in a first-order stream in the Fynbos Biome in South Africa between May 1984 and April 1985. Monthly falls into Window Stream of all litter types (total) ranged from 11 (September) to 79 (March) g/sq-m. Total annual litter fall was 426 g dry weight, which corresponds to 1.2 g/sq-m/d. Flowers, fruits, and seeds contributed 37 g/sq-m, woody debris, 122 g/sq-m, and leaves 267 g/sq-m to this total. Leaf fall from native trees, which accounted for approximately 57% of total litter input (244 g/sq-m/a), was significantly higher in summer than in winter. The summer peak in leaf fall recorded is far smaller and more protracted than the autumnal peak recorded for many Northern Hemisphere streams. Monthly total standing stocks of CPOM ranged from 14 g dry weight/sq-m in January to 69 g/sq-m in August, and a mean total CPOM standing stock of 41 g/sq-m/month was estimated. This comprised 18 g/sq-m/month soft litter, and 23 g/sq-m/month hard litter. CPOM standing stocks showed no seasonal trends, and with the exception of two species, standing stocks of endemic leaf species reflected their contributions to the total litter fall. Contrary to earlier reports for streams in the Fynbos Biome, Window Stream has CPOM standing stocks well within the ranges reported for low-order streams worldwide. (Author's abstract)
W91-03488

ORDINATION ANALYSIS AND BIOINDICES BASED ON ZOOBENTHOS COMMUNITIES USED TO ASSESS POLLUTION OF A LAKE IN SOUTHERN FINLAND.
Ristola (Paavo) Consulting Engineers Ltd., Hollola (Finland).
For primary bibliographic entry see Field 5A.
W91-03490

DEPTH-TIME DISTRIBUTIONS OF DETRITUS DEPOSITIONS IN LAKE NEMI (VOLCANIC LAKE OF CENTRAL ITALY).
Rome Univ. (Italy). Dipt. di Genetica e Biologia Molecolare.
L. Rossi, L. Picciafuoco, and A. Basset.
Hydrobiologia HYDRB8, Vol. 202, No. 3, p 185-195, August 31, 1990. 4 fig, 2 tab, 28 ref.

Descriptors: *Deposition, *Detritus, *Italy, *Lake sediments, *Limnology, *Organic matter, Bottom sediments, Cores, Ecosystems, Littoral zone, Plankton, Sediment analysis, Sedimentation.

Organic detritus is an important component of lake ecosystems. The depth-time distributions of detritus depositions onto lake bottom and the amount of resident organic matter on the upper layer of the bottom have been assessed in a volcanic lake (Lake Nemi in central Italy). Depositions were sampled monthly across the lake at four depths (0.2 m, 2 m, 6 m, and 30 m) during two years (1983-1984). Organic and ash fractions of sediment cores collected along a depth gradient were assessed in the summer of 1984. The results show: (1) the mean amount of organic matter deposition (size $>$ 10 micrometers) is 1.24 g/sq-m/d dry weight (452.6 g/sq-m/year); (2) the metabolism of large particulate organic matter (LPOM) occurs primarily in the littoral zones not farther than 30 m offshore and the dispersibility of the LPOM may be predicted by a negative exponential model; (3) the deposition on the bottom comprised under the perimeter of about 80% of the lake surface, is principally autochthonous (planktonic in origin); and (4) the detritus settled out of the water column is not completely processed and about half of the total material enters the slow cycle of the sediment in the deepest zone of the lake. (Author's abstract)
W91-03491

FACTORS INFLUENCING FISH DISTRIBUTION AND COMMUNITY STRUCTURE IN A SMALL COASTAL RIVER IN SOUTHWESTERN COSTA RICA.
Wisconsin Univ.-Madison. Center for Limnology.
J. Lyons, and D. W. Schneider.
Hydrobiologia HYDRB8, Vol. 203, No. 1/2, p 1-14, September 14, 1990.4 fig, 4 tab, 41 ref.

Descriptors: *Aquatic habitats, *Coastal streams, *Costa Rica, *Fish populations, *Species diversity, *Stream ecology, Adaptation, Population density, Population dynamics, Riffles, River mouth, Saline water intrusion, Species composition, Tidal effects.

An evaluation was made of the relative importance of habitat size and diversity and distance from the ocean in explaining longitudinal patterns of fish distribution and community structure (species richness, evenness, and diversity) in the lower 5 km of the Rio Claro, a small coastal river in Corcovado National Park, southwestern Costa Rica, with a depauperate freshwater fish fauna. Twenty-two species in pools were observed, 19 of which occurred during quantitative sampling. Most of these species probably spent part of their lives in the Pacific Ocean. No species were observed in riffles, although these habitats were common and several taxa were adapted for life in fast turbulent water. Fish abundance, and species richness, evenness, and diversity were highest near the ocean, where high tides influenced river levels and salinity. Eight species were not observed further than 2900 m from the ocean, whereas six species were not encountered in samples nearest the ocean; the remaining eight species were present throughout the study area. Distance from the ocean was a better predictor of fish abundance and community structure than were pool width, pool depth, pool surface area, pool volume, amount of cover present, substrate diversity, or depth diversity. Qualitative comparisons of this data with previously-published data from 1980-1986, the fish assemblage of the Rio Claro is persistent in both species composition and relative abundance. (Author's abstract)
W91-03492

DYNAMIC ASPECT OF COARSE PARTICULATE ORGANIC MATTER (CPOM) ON THE SEDIMENT SURFACE OF A SECOND ORDER STREAM FREE OF DEBRIS DAMS (RITRODAT-LUNZ STUDY AREA).
Oesterreichische Akademie der Wissenschaften, Vienna. Inst. fuer Limnologie.
G. Bretschko.
Hydrobiologia HYDRB8, Vol. 203, No. 1/2, p 15-28, September 14, 1990. 9 fig, 6 tab, 27 ref.

Descriptors: *Austria, *Deposition, *Nutrient transport, *Organic matter, *Retention capacity, *River sediments, *Stream ecology, *Streams, Bottom sediments, Flood plains, Leaves, Riparian vegetation, Seasonal variation, Stream discharge, Stream order.

Allochthonous organic matter is the main energy basis for low order streams; quantity and quality of imported organic matter are important parameters, defining density and composition of the stream biocoenosis. Oberer Seebach, in the eastern alps of Austria, is a second order stream, draining an uninhabited and densely forested catchment. Because of flood control, the channel has been free of debris dams for more than a century. The study site is characterized by riparian vegetation and the distribution of dry and channel overflow areas. Amounts of leaf material deposited on the sediment surface of the channel are significantly larger during defoliation (20 days) and shortly afterwards ('accumulation period,' 6.64 g/sq-m (110 days) and 29.42 g/sq-m dry weight (133 days, mean of five years) for wet and dry areas, respectively) than during the rest of the year ('intermediate period,' 0.98 and 3.94 g/sq-m (mean of five years) for wet and dry areas, respectively). Woody debris is too scarce to increase the retention capacity. Deposition of leaf material depends on the interaction of input (wind-drift and bank runoff, 124 and 85 g/sq-m for the accumulation and intermediate period, respectively), discharge regime and the relationship between dry and wet channel areas. Periodically inundated areas increase the retention capacity of the stream channel and are comparable with the interrelationship between stream and flood plain. (Author's abstract)
W91-03493

PREDOMINANCE OF PICOPLANKTON AND NANOPLANKTON IN EUTROPHIC CALDER LAKE.
Fordham Univ., Armonk, NY. Louis Calder Conservation and Ecology Study Center.
J. D. Wehr.
Hydrobiologia HYDRB8, Vol. 203, No. 1/2, p 35-44, September 14, 1990. 7 fig, 3 tab, 33 ref.

Descriptors: *Algae, *Eutrophic lakes, *Limiting nutrients, *Limnology, *Phytoplankton, Biomass, Cyanophyta, Dinoflagellates, Ecosystems, Microbiological studies, New York, Nitrogen, Nutrient concentrations, Phosphorus, Primary productivity.

A study was conducted to examine factors regulating the biomass of algal picoplankton in Calder Lake, a small eutrophic lake in southern New York state. A particular focus was a current paradigm which suggests that larger cells may dominate in

nutrient-rich waters, while smaller cells may predominate only in oligotrophic waters. Over two years, phytoplankton biomass consisted predominantly (74% on average) of very small organisms; nanoplankton (<20 to 2 micrometers: 39%) and picoplankton (<2 micrometers to 0.2 micrometers: 35%), despite the presence of surface blooms of colonial cyanobacteria (Microcystis aeruginosa, Anabaena limnetica), and dense metalimnetic populations of the dinoflagellate Ceratium hirundinella. This dimictic system is characterized by relatively high levels of total P, inorganic P, and total inorganic N, but larger forms were rarely the most abundant. Unlike some marine systems, greater abundance of algal picoplankton was not associated with deeper strata (low light), or warmer temperatures. Data suggest that midsummer nutrient limitation, especially P-limitation, favors the development of picoplankton and nanoplankton in the limnetic zone of eutrophic lakes. (Author's abstract)
W91-03494

LITTERFALL, LEAF DECOMPOSITION AND LITTER COLONIZATION OF TESSARIA INTEGRIFOLIA (COMPOSITAE) IN THE PARANA RIVER FLOODPLAIN.
Centro de Ecologia Aplicada del Litoral, Corrientes (Argentina).
J. J. Neiff, and A. P. de Poi.
Hydrobiologia HYDRB8, Vol. 203, No. 1/2, p 45-52, September 14, 1990. 2 fig, 2 tab, 31 ref.

Descriptors: *Colonization, *Decomposing organic matter, *Flood plain sediments, *Floodplain forests, *Invertebrates, *Leaves, *Litter, *Parana River, *Stream ecology, Argentina, Forest ecosystems, Nutrient concentrations, Organic matter, River sediments, Seasonal variation.

Litterfall and leaf decomposition rates were measured in Choui Island, 45 km downstream from the confluence of the Parana and Paraguay Rivers, in Argentina. The material was collected biweekly from April 1985 through September 1986. Decomposition was measured in situ by the litter bag technique. Annual litterfall of Tessaria integrifolia gallery forest measured in the period April 1985 to March 1986 was 8.15 t/ha. Leaf litterfall was seasonal, i.e. significantly less leaf litter was shed during the high water phase than during the low water phase. The 'half life' of the T. integrifolia litter over 38 days of decomposition was 20 days. At the beginning of the experiment, 15 and 38 days subsamples of remaining detritus were analyzed in order to determine changes in the nutrient content. After 38 days of incubation, the order of nutrient disappearance was Ca>K>N>Mg>Na>P. The number of invertebrates per g remaining litter of T. integrifolia increased between incubations days 7 and 31. Collector-gatherers were more abundant after 38 days incubation; there were no shredders colonizing the leaf litter bags. (Author's abstract)
W91-03495

ACCURACY OF POPULATION DENSITY ESTIMATES OF A HORIZONTALLY DISTRIBUTED ZOOPLANKTON COMMUNITY IN DUTCH FISH PONDS.
Agricultural Univ., Wageningen (Netherlands). Dept. of Fish Culture and Inland Fisheries.
J. Verreth.
Hydrobiologia HYDRB8, Vol. 203, No. 1/2, p 53-61, September 14, 1990. 5 tab, 18 ref.

Descriptors: *Fish ponds, *Limnology, *Sampling, *The Netherlands, *Zooplankton, Copepods, Distribution patterns, Fish farming, Microbiological studies, Population density, Precision, Variation coefficient, Waterfleas.

To elucidate the effect of the horizontal distribution of different zooplankton populations on the accuracy of population density estimates in a fish pond, 40 samples were taken according to a rectangular grid which divided the pond into 5 longitudinal rows and 10 transversal columns. The zooplankton consisted of 55% copepods, 43% cladocerans, and 2% Rotatoria. The index of patchiness was mostly higher than 1, revealing a strongly clumped distribution. A more passive wind-induced distribution was detected for most taxonomic groups. Based on the calculated coefficients of variation, a table of the accuracies of the density estimates in relation to the number of samples was presented. For more detailed studies on a particular species population, about 25 samples (column samples of 10 L each) are needed to obtain an accuracy varying between 10 and 20%, depending on the taxonomic group. A slightly higher precision can be obtained, however at a strongly increasing effort. For the practice of fish farming, two to five sample stations should suffice to estimate the total zooplankton abundance with a 30 to 10% accuracy respectively. (Author's abstract)
W91-03496

IMPACT OF MILD EXPERIMENTAL ACIDIFICATION ON SHORT TERM INVERTEBRATE DRIFT IN A SENSITIVE BRITISH COLUMBIA STREAM.
British Columbia Univ., Vancouver. Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W91-03497

DEVELOPMENT AND APPLICATION OF A TECHNIQUE FOR ESTIMATING NUTRIENT DEFICIENCY IN SOFT SEDIMENTS.
Montana State Univ., Bozeman. Dept. of Biology.
For primary bibliographic entry see Field 7B.
W91-03499

HYPOLIMNETIC PROTOZOAN PLANKTON OF A EUTROPHIC LAKE.
Lancaster Univ. (England). Dept. of Biological Sciences.
J. Laybourn-Parry, J. Olver, and S. Rees.
Hydrobiologia HYDRB8, Vol. 203, No. 1/2, p 111-119, September 14, 1990. 7 fig, 27 ref. Natural Environment Research Council Grant GR3/6957.

Descriptors: *Eutrophic lakes, *Hypolimnion, *Limnology, *Plankton, *Protozoa, Benthic environment, Benthos, Biomass, Ecosystems, Epilimnion, Lake stratification, Migration, Population density, Seasonal distribution, Seasonal variation, Species composition, Thermocline.

The importance of the microzooplankton in ecological processes such as energy flow and biogeochemical cycling in the marine environment is well established. Freshwater studies have lagged behind, but there is a growing pool of information on the occurrence and importance of protozoan biomass in the plankton lakes from a range of latitudes. The seasonal distribution of benthic species in the water column above and below the thermocline in a small eutrophic lake was studied. During summer stratification populations of Spirostomum spp., Loxodes spp., Plagiopyla and Deltopylum become established in the plankton on or below the oxycline/thermocline. At shallow sites no migration occurred and populations of the migratory species in the benthos were sparse, with the exception of Plagiopyla which occurred in high densities in the sediment. Two distinct planktonic populations are established during stratification: an epilimnetic community of obligate planktonic ciliates and a hypolimnetic community of benthic migrants. (Author's abstract)
W91-03500

EVALUATION OF THE FISHERIES OF THE MACKINAW RIVER BASIN IN CENTRAL ILLINOIS.
Illinois Dept. of Conservation, Aledo.
D. M. Day, R. W. Sauer, and W. A. Bertrand.
Transactions of the Illinois Academy of Science TISAAH, Vol. 83, No. 1/2, p 82-100, 1990. 4 fig, 5 tab, 25 ref. Federal Aid to Sport Fish Restoration Project F67R; Illinois Department of Conservation, Division of Fisheries.

Descriptors: *Black bass, *Ecological effects, *Fish populations, *Illinois, *Stream fisheries, *Water pollution effects, Bass, Carp, Habitats, Recreation demand, Species composition, Species diversity, Stream biota, Water quality trends, Water resources management.

In 1987, on the Mackinaw River Basin in central Illinois, fish data were collected as part of an ongoing effort by the Illinois Department of Conservation (IDOC) Streams Program to assess statewide stream quality. Fifty-nine fish species were collected from 22 sites. On the Mackinaw River, stations downstream of the town of Mackinaw showed generally lower evenness, lower species richness and lower 'biotic integrity' as indicated by the Alternated Index of Biotic Integrity (AIBI), compared to stations upstream. More intensive investigations are warranted to isolate the habitat or water quality parameters responsible for this change and to determine the potential for implementation of habitat enhancement techniques in this downstream section. Several tributaries, including Panther Creek, Walnut Creek, and Henline Creek, were very high quality as seen with the IBI and appear to be smallmouth bass nurseries. Fish body condition as estimated by relative weight, was good for carp (values near 100) and fair for smallmouth bass (values ranging from 80 to 95). With its diverse fish fauna, aesthetic value, multiple recreational uses including fishing, swimming, canoeing, and hiking, the Mackinaw River represents one of the highest quality streams in Illinois and it is within the public interest to protect this stream from deleterious impacts. (Author's abstract)
W91-03504

ENVIRONMENTAL STUDY ON CHEMICAL POLLUTION OF THE LAKE KORONIA IN NORTHERN GREECE.
Thessaloniki Univ., Salonika (Greece). Lab. of Analytical Chemistry.
For primary bibliographic entry see Field 5B.
W91-03534

DYNAMICS OF TURBIDITY CURRENTS MEASURED IN KATSURAZAWA RESERVOIR, HOKKAIDO, JAPAN.
Hokkaido Univ., Sapporo (Japan). Dept. of Geophysics.
K. Chikita, and Y. Okumura.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 323-338, September 1990. 9 fig, 2 tab, 23 ref.

Descriptors: *Lake sediments, *Reservoirs, *Sediment discharge, *Sediments, *Turbidity currents, *Turbidity flow, Diurnal variation, Flow velocity, Hokkaido, Japan, Katsurazawa Reservoir, Mathematical analysis, Reservoir sediments, Reynolds number, Temperature gradient, Underflow, Water temperature.

The movement of turbid underflows in a reservoir was examined using three recording current meters. The density underflows, called turbidity currents, are induced by sediment discharge in the inflow system during the spring thaw. Continuous measurement near the reservoir bottom at two longitudinally located stations showed the characteristic diurnal variations of flow velocity and temperature, and decreasing temperature in the downslope direction. The diurnal temperature variations correspond to the diurnal variations of sediment discharge and its temperature in the inflow system, and the decreasing temperature downslope is explained by the entrainment of upper, cold water which turbidity currents induce. Assuming the water temperature to be 0 C, two mixing coefficients and turbidity-current discharge at the stations were numerically obtained. Applying Manning's equation to the critical, low turbidity-current discharge, a value of 1.51 was obtained for the roughness coefficient, n. Hence, assuming n to be constant, Reynolds number, Re, and densimetric Froude number, Fd, for the turbidity currents were evaluated at 71,000-580,000 and 1.5-4.4, respectively. The entrainment coefficient, Ee, from the equation of continuity holds a significant correlation with 'overall Richardson number'. Decreasing entrainment is due to decreasing friction at the interface with the relative increase of kinetic energy. This could be applied to turbidity currents with Re of the order of 100,000. The downslope movement of turbidity currents with the diurnal variations of discharge and temperature is also explained by the longitudinal propagation of long

waves. These could change from kinematic to intermediate waves with increasing discharge. (Author's abstract)
W91-03555

PEORIA LAKE SEDIMENTATION AND PROPOSED ARTIFICIAL ISLANDS.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 5G.
W91-03614

SEDIMENT MANAGEMENT PROBLEMS OF BACKWATER LAKES AND ALTERNATIVE SOLUTIONS.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 2J.
W91-03615

HABITAT RESTORATION FOR FISH AND WILDLIFE IN BACKWATER LAKES OF THE ILLINOIS RIVER.
Illinois State Water Survey, Peoria. Water Quality Section.
For primary bibliographic entry see Field 5G.
W91-03616

ILLINOIS RIVER BASIN: LIFEBLOOD OF OUR STATE.
Illinois Dept. of Energy and Natural Resources, Springfield.
For primary bibliographic entry see Field 6G.
W91-03619

VALUE OF CITIZEN STREAM QUALITY MONITORING AS AN EDUCATIONAL TOOL.
Wheaton Park District, IL.
For primary bibliographic entry see Field 5G.
W91-03624

USEPA PERSPECTIVE ON NONPOINT POLLUTION CONTROL AND WETLANDS FUNCTION.
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 5G.
W91-03631

ECOLOGY OF ESTUARIES. VOLUME II: BIOLOGICAL ASPECTS.
Cook Coll., New Brunswick, NJ. Fisheries and Aquaculture Technology Extension Center.
For primary bibliographic entry see Field 2L.
W91-03658

GREAT LAKES: LIVING WITH NORTH AMERICA'S INLAND WATERS.
Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. 296p. Edited by D. H. Hickcox.

Descriptors: *Great Lakes, *Lake management, *Symposium, *Water policy, *Water resources management, Canada, Climatic changes, Groundwater, Lake fisheries, Lake shores, Recreation, Water pollution sources, Water quality control, Water use.

The Great Lakes of North America, the world's largest assemblage of fresh water, have exerted tremendous influence on the settlement and economic development of North America's interior. Today, 40 million people in eight states and two provinces inhabit the Great Lakes basin. Issues facing the Great Lakes include lakeshore development; increased recreation; domestic and industrial water use; sanitation; navigation; electrical power generation by nuclear, coal-fired, and hydroelectric plants; irrigation; fisheries; wetland preservation; endangered species preservation; shoreline protection; and lake levels. Perhaps the most serious problem facing the Great Lakes is water pollution in its many facets: nonpoint pollution, point source pollution, airborne, in-place (lakebed sediments), and pollution from groundwater. The intense urbanization of the Great Lakes basin and extensive agriculture in the basin ensure that large amounts of pollutants enter the lakes. The papers included in the Great Lakes symposium address many of the problems facing the Great Lakes. They are generally organized into sections covering: Great Lakes policy and management, water levels, climate, water quality, groundwater, and fisheries and recreation. Their authors have been educated in several different disciplines and represent many different constituencies. Some papers focus on site-specific topics; others are wide-ranging in scope and not every topic is evenly covered. However, all authors share a mutual concern for the Great Lakes and the pressing need to find common solutions to the diverse problems facing the lakes. (See W91-03673 thru W91-03703) (Fish-PTT)
W91-03672

GREAT LAKES INSTITUTIONS AND THE POLICY PROCESS: ISSUES IN INTERSTATE AND INTERNATIONAL RESOURCE MANAGEMENT.
Great Lakes Commission, Ann Arbor, MI.
For primary bibliographic entry see Field 6B.
W91-03673

GREAT LAKES RESEARCH NEEDS AND HOW TO MEET THEM.
Michigan Dept. of Natural Resources, Lansing. Office of the Great Lakes.
For primary bibliographic entry see Field 6B.
W91-03674

AGENDA FOR THE MANAGEMENT OF THE GREAT LAKES ON A LONG TERM ECOSYSTEM BASIS.
Cornell Univ., Ithaca, NY.
For primary bibliographic entry see Field 6E.
W91-03675

REASSESSING ESTIMATES OF GREAT LAKES CONSUMPTIVE USES AND IMPACTS.
Corps of Engineers, Chicago, IL. North Central Div.
For primary bibliographic entry see Field 6D.
W91-03676

REMEDIAL ACTION PLANS: A GREAT LAKES PROGRAM WHOSE TIME HAS COME.
International Joint Commission-United States and Canada, Windsor (Ontario).
For primary bibliographic entry see Field 6B.
W91-03677

MANAGEMENT OF LAKE ONTARIO RESOURCES: A HOLISTIC PERSPECTIVE.
State Univ. of New York at Buffalo.
R. W. Flint.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 53-64, 2 fig, 2 tab, 34 ref.

Descriptors: *Great Lakes, *Lake Ontario, *Lake management, *Limnology, *Path of pollutants, *Water pollution effects, *Water resources management, Aquatic productivity, Ecological effects, Ecosystems, Environmental impact, Fish conservation, Organic pollutants, Regulations, Water pollution sources, Water quality management.

In light of ever-increasing demand and multiple use of Lake Ontario resources, a clear understanding of the complex interactions among and between system components is vital. Data from various disciplines were examined to determine some of the long-term trends in Lake Ontario and to suggest some potential causative factors for changes observed over time. Demographic shifts coupled with environmental regulations have played a major role in improving water quality. Decreases in phosphorus and phytoplankton, although corresponding to decreased system loading, also appear to be affected by increases in fish biomass from stocking. Linkages between toxic contaminants and system production are becoming more evident. Interlake comparisons suggest less productive systems are more heavily burdened with toxic reserves than more productive systems. There is also evidence demonstrating long-term persistence of these chemicals in Lake Ontario: indicator organisms in sediment profiles; trace organic contaminants in herring gull eggs and lake trout; and interlake ecosystem cycling. It is evident that natural resource managers must develop a better appreciation for the interconnectedness of water quality and fisheries resources problems associated with managing ecological processes, which are often viewed otherwise in isolation from one another. (See also W91-03672) (Fish-PTT)
W91-03678

CHICAGO AND ITS LAKEFRONT: LIVING ON THE EDGE.
Chicago Shoreline Protection Commission, IL.
For primary bibliographic entry see Field 6G.
W91-03679

FLUCTUATING GREAT LAKES WATER LEVELS: EXPECTATIONS AND THE IJC.
International Joint Commission-United States and Canada, Ottawa (Ontario).
For primary bibliographic entry see Field 6E.
W91-03680

GREAT LAKES WATER LEVELS, PAST, PRESENT, AND FUTURE.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
F. H. Quinn.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 83-92, 5 fig, 3 tab, 15 ref.

Descriptors: *Gaging, *Great Lakes, *Lake management, *Water level fluctuations, *Water resources management, Climatic changes, Consumptive use, Diversion, Glaciation, Global warming, Lake shores, Regulations, Riparian land, Seasonal variation, Storm surges.

The Great Lakes are one of our nation's greatest water resources containing 95% of the nation's and 20% of the world's fresh surface water. At the present time, all of the Great Lakes except for Lake Ontario, are receding from record high lake levels for this century. The high lake levels have had a severe impact upon the riparian interests around the lakes. Storms superimposed on the high lake levels have resulted in extensive flooding, houses destroyed, extreme erosion and bluff damage, marina problems, and a loss of habitat for various forms of wildlife. Historic fluctuations began with the retreat of the glaciers around 11,000 years ago, essentially stabilizing about 3,000 years ago. Gaging began in 1860, showing fluctuations from 183.40 m maximum (Lake Superior) to 73.86 m minimum (Lake Ontario). Seasonal cycles (30 to 45 cm) are superimposed on the annual cycles. Event-related fluctuations include storm surge, wind setup, and pressure jumps. The recorded lake levels include the effects of diversions, lake regulation, modifications to connecting channels, and consumptive use. Present lake levels show a rapid drop in November 1986 following the peak of the past high levels regime in 1986. Future Great Lakes levels scenarios can be developed on the basis of both normal climatic variability and the implication of global climatic warming. Higher lake level sequences could be expected in the future. It is important that policy analysis consider a wide range in water levels rather than concentrating only on the high lake level conditions of the past two decades or on the recent drought conditions. (See also W91-03672) (Fish-PTT)
W91-03681

GREAT LAKES WATER RESOURCES MANAGEMENT.
Corps of Engineers, Chicago, IL. North Central Div.

For primary bibliographic entry see Field 6E.
W91-03682

GREAT LAKES--NATURE'S PLAYGROUND.
Army Engineer District, Detroit, MI.
D. L. Schweiger, and N. Noorbakhsh.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 103-110, 9 fig, 7 ref.

Descriptors: *Climatic effects, *Great Lakes, *Lake management, *Water level fluctuations, *Water resources management, Climatic changes, Evaporation, Forecasting, Meteorology, Precipitation, Weather forecasting.

The Great Lakes and their connecting channels make up the largest body of fresh water in the world, with a total surface area of almost 95,000 square miles. Because of the vast land area and population that is influenced by the Great Lakes, fluctuations in the water levels are always a concern to the riparians and the users of this system. In the last 25 years, the Great Lakes have experienced a broad spectrum of water levels, from the mid-1960s lows to the mid-1970 and mid-1980 highs. Although there are many factors, artificial and natural, which affect lake levels, precipitation and evaporation are the prime causes of lake level fluctuations. Long-term fluctuation in the water levels are the result of persistent periods of wet or dry weather. While seasonal variations are moderately predictable, extreme climatic events and the duration of wet or dry periods are not predictable. Present predictions are based on analyses of historic data, including trends in water supplies to the lakes, antecedent precipitation and temperatures, and weather forecasts one month into the future. More dependable and longer-range weather forecasts would substantially improve the reliability of the lake level forecasts, and better enable management of this massive system. (See also W91-03672) (Fish-PTT)
W91-03683

LAKE SUPERIOR'S HIGH WATER LEVEL AND DAMAGES: A DELICATE BALANCE.
Minnesota Dept. of Natural Resources, St. Paul.
For primary bibliographic entry see Field 6B.
W91-03684

ONTARIO HYDRO IMPACTS ON THE GREAT LAKES--AND VICE VERSA.
Ontario Hydro, Toronto.
For primary bibliographic entry see Field 6G.
W91-03685

TEMPORAL CHANGES IN HEAVY RAINFALL FREQUENCIES IN THE GREAT LAKES BASIN.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 2B.
W91-03686

REVIEW OF PUBLIC PARTICIPATION IN THE GREAT LAKES WATER QUALITY AGREEMENT.
League of Women Voters of Michigan, Brighton.
For primary bibliographic entry see Field 6B.
W91-03687

MANAGEMENT APPROACHES WITHIN THE 1987 US/CANADA GREAT LAKES WATER QUALITY AGREEMENT.
Environmental Protection Agency, Chicago, IL. Great Lakes National Program Office.
For primary bibliographic entry see Field 6B.
W91-03688

SIGNIFICANCE OF GIS AND REMOTE SENSING TECHNOLOGY IN GREAT LAKES MONITORING AND RESOURCE MANAGEMENT.
Wisconsin Univ.-Madison. Environmental Remote Sensing Center.
For primary bibliographic entry see Field 7B.
W91-03689

GEOPHYSICAL DETERMINATION OF LAKEBED SEDIMENT HYDRAULIC PROPERTIES.
Wisconsin Univ.-Milwaukee. Dept. of Geosciences.
For primary bibliographic entry see Field 7B.
W91-03690

UNITED STATES NONPOINT SOURCE PHOSPHORUS REDUCTION EFFORT.
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 5G.
W91-03691

ASSESSMENT OF AGRICULTURAL NONPOINT SOURCE POLLUTION POTENTIALS IN THE CANADIAN GREAT LAKES BASIN.
Guelph Univ. (Ontario). Dept. of Land Resource Science.
For primary bibliographic entry see Field 5B.
W91-03692

COLONIAL WATERBIRD DEFORMITIES--AN EFFECT OF TOXIC CHEMICAL RESIDUES IN THE GREAT LAKES.
Ecological Research Service, Inc., Bay City, MI.
For primary bibliographic entry see Field 5C.
W91-03694

PHOSPHORUS LEVELS IN ONTARIO STREAMS TRIBUTARY TO THE GREAT LAKES A DECADE AFTER PLUARG.
Ontario Ministry of the Environment, Toronto.
For primary bibliographic entry see Field 5B.
W91-03695

LAKE MICHIGAN TOXIC POLLUTION CONTROL/REDUCTION STRATEGY.
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 5G.
W91-03696

LAND-USE CHANGES: EFFECT ON WATER QUALITY IN THE PINE CREEK WATERSHED.
Lapeer County Drain Commission, MI.
For primary bibliographic entry see Field 4C.
W91-03697

GEOHYDROLOGY OF A THIN WATER-TABLE AQUIFER ADJACENT TO LAKE MICHIGAN, NORTHWESTERN INDIANA.
Geological Survey, Indianapolis, IN.
For primary bibliographic entry see Field 2F.
W91-03698

WATER QUALITY IN A THIN WATER-TABLE AQUIFER ADJACENT TO LAKE MICHIGAN, WITHIN A HIGHLY INDUSTRIALIZED REGION OF INDIANA.
Geological Survey, Indianapolis, IN.
For primary bibliographic entry see Field 5B.
W91-03699

DEVELOPMENT OF THE LAKE ONTARIO SPORTFISHERY: SOCIOECONOMIC IMPACTS IN NEW YORK STATE.
New York Sea Grant Extension Program, Oswego.
C. P. Dawson, and M. P. Voiland.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 259-268, 2 tab, 21 ref.

Descriptors: *Great Lakes, *Lake Ontario, *Lake management, *New York, *Recreation, *Sport fishing, *Water resources management, Boating, Economic impact, Ecosystems, Lake fisheries, Recreation demand, Social aspects, Water resources development.

Successful redevelopment of the Lake Ontario sportfishery by the New York State Department of Environmental Conservation began with the salmonid stocking program in 1968. The socioeconomic impacts of the sportfishery's development have not been as carefully monitored as the biological parameters and impacts. Fishery resource rehabilitation success on Lake Ontario stimulated coastal community facility and services development. Large increases in angler participation has spurred the development of the charter boat fishing industry, boater and angler access sites, fishing debris, the opening of new fishery-related businesses, and additional employment. Significant seasonal economic impacts from angler trip expenditures have occurred in many coastal communities. Less positive social and economic impacts are also reported such as trespassing, highway congestion, user conflicts, boating facility shortages, increased demand for community services, seasonal employment, concern for fish contaminants, and increased land values. Dramatic resource rehabilitation has led to increasing expectations by sportfishery constituencies for continued growth. A better assessment of and development for sportfishery user needs are necessary. Future management directions will require a greater consideration of social and economic, as well as biological, dimensions of fishery management to effectively and wisely utilize and protect Great Lakes fishery resources. (See also W91-03672) (Author's abstract)
W91-03700

RECREATIONAL BEACH ENVIRONMENT: PERCEPTIONAL DIFFERENCE OF USERS, EMPLOYEES, AND THE PUBLIC.
State Univ. of New York Coll. at Cortland. Dept. of Recreation and Leisure Studies.
For primary bibliographic entry see Field 6D.
W91-03701

DISCUSSION OF LAKE MICHIGAN RIP CURRENT HAZARDS TO SWIMMERS.
Indiana Dunes National Lakeshore, Porter, IN.
R. G. Littlefield.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 279-284, 2 fig, 3 ref.

Descriptors: *Great Lakes, *Lake Michigan, *Lake management, *Recreation, *Rip currents, *Water resources management, Drowning, Indiana, Public waters, Sandbars, Swimming, Water currents.

The southern shoreline of Lake Michigan provides an estimated 15 million regional people a unique recreational opportunity in the form of some of the finest swimming and bathing beaches in this country. Unfortunately, from time to time, weather and nearshore conditions combine to form deadly rip currents which may be responsible for more than half of the water-related fatalities which occur on Lake Michigan beaches each summer. A rip current has the potential of transporting the unwary swimmer out into the deeper water beyond the reach of the shore very rapidly, usually before the average person can react in a defensive manner, and can cause the swimmer to panic and even drown. Rip currents are formed along the southern shore of Lake Michigan when northerly winds cause waves to break on the shallow nearshore sandbar in rapid succession, causing a current to form in the trough and flow parallel to the beach and toward the lowest part of the sandbar. As the water flows across this low area, it erodes a channel which allows the excess water behind the bar to spill lakeward as a powerful rip current. Ironically, the very forces that create rip currents can save swimmers and rescuers alike if they understand that: once carried beyond the sandbar, the current's strength greatly diminishes into a large slow vortex. A swimmer caught in this current should not attempt to swim shoreward against the current, but should swim to one side or the other and get out of the current to where the incoming

waves will carry them shoreward again. An understanding of the mechanics which cause rip currents can aid managers in reducing public exposure and the potential of liability. Experience gained from actions taken at Indiana Dunes National Lakeshore is readily transferable to other lakeshore situations. (See also W91-03672) (Fish-PTT)
W91-03702

EXCURSION, CRUISE AND PASSENGER FERRY SERVICES ON THE GREAT LAKES AND ST. LAWRENCE RIVER.
Great Lakes Commission, Ann Arbor, MI.
For primary bibliographic entry see Field 6D.
W91-03703

BIOMANIPULATION: RETROSPECTIVE AND FUTURE DEVELOPMENT.
Kinneret Limnological Lab., Tiberias (Israel).
For primary bibliographic entry see Field 5G.
W91-03761

ARE BLUE-GREEN ALGAE A SUITABLE FOOD FOR ZOOPLANKTON: AN OVERVIEW.
Istituto Italiano di Idrobiologia, Pallanza (Italy).
R. de Bernardi, and G. Giussani.
Hydrobiologia HYDRB8, Vol. 200/201, p 29-41, August 27, 1990. 9 fig, 3 tab, 55 ref.

Descriptors: *Algal control, *Cyanophyta, *Diets, *Eutrophic lakes, *Food chains, *Lake restoration, *Limnology, *Zooplankton, Biomanipulation, Bioremediation, Food habits, Water quality management.

One of the reasons suggested to explain the dominance of blue-green algae in eutrophic lakes is that they are not used as food by zooplankton, and even when ingested are poorly utilized. An increase in herbivores might be expected to result from biomanipulation of the aquatic food chain. A series of in-lake experimental results indicates that, after the food chain has been biomanipulated, there is a decrease in blue-green density in periods when there is an increase in herbivores. A question remaining is whether this is an accidental result or whether the two observations are related. The suitability of blue-greens as food for zooplankton has been investigated by many workers, with contrasting and inconclusive results. Two main factors seem to play important roles in determining the suitability of blue-green algae as food: (1) the biochemical properties of the different species, or different strains of the same species, and (2) the shape and size of the colonies. Biochemical properties can cause toxic effects on zooplankton, whereas size and shape may interfere strongly with filtering, thus reducing the possibility of gathering food. (Author's abstract)
W91-03763

EFFECTIVENESS OF PHYTOPLANKTON CONTROL BY LARGE-BODIED AND SMALL-BODIED ZOOPLANKTON.
Warsaw Univ. (Poland). Dept. of Hydrobiology.
For primary bibliographic entry see Field 5G.
W91-03764

ANALYSIS OF PHYTOPLANKTON-ZOOPLANKTON RELATIONSHIPS IN AN OLIGOTROPHIC LAKE UNDER NATURAL AND MANIPULATED CONDITIONS.
Granada Univ. (Spain). Dept. de Biologia Animal, Ecologia y Genetica.
P. Carrillo, L. Cruz-Pizarro, and P. Sanchez-Castillo.
Hydrobiologia HYDRB8, Vol. 200/201, p 49-58, August 27, 1990. 4 fig, 2 tab, 38 ref. Junta de Andalucia Project 9/88.

Descriptors: *Biocontrol, *Biomanipulation, *Ecosystems, *Lake restoration, *Limnology, *Plankton, *Spain, Chlorophyll a, Food habits, Lake La Caldera, Limiting nutrients, Limnocorrals, Nutrients, Oligotrophic lakes, Phytoplankton, Predation, Water quality management, Zooplankton.

During August, 1987, a series of limnocorral experiments was performed in lake La Caldera (southern Spain), a small winter-kill lake in which phytoplankton is strikingly nutrient-limited. The effects of biomanipulation on zooplankton-phytoplankton relationships was assessed by monitoring both individual species and whole-assemblage responses. Two sizes of enclosures were used (15 and 350 L) and two treatments were examined: (1) removal of zooplankton by 45-micrometer filter net and (2) doubling the natural grazing pressure by increasing the zooplankton concentration. Results show the two enclosure types to differ strikingly: flagellates disappeared from the small enclosures, resulting in four-fold to six-fold changes in chlorophyll a concentration and three-fold to four-fold changes in the number of individuals. Most species were grazed (a prey selectivity based on criteria other than size was observed) and their net growth rate increased with zooplankton concentration, causing a net increase in phytoplankton growth, a stimulatory effect probably related to nutrient regeneration that overrides the losses due to grazing. (Author's abstract)
W91-03765

BIOMANIPULATION BY INTRODUCTION OF HERBIVOROUS ZOOPLANKTON: A HELPFUL SHOCK FOR EUTROPHIC LAKES.
Institut fuer Entwicklung und Forschung Dr. Vielberth K.G., Regensburg (Germany, F.R.).
For primary bibliographic entry see Field 5G.
W91-03766

ZOOPLANKTON-PHYTOPLANKTON INTERFACE IN LAKES OF CONTRASTING TROPHIC STATUS: AN EXPERIMENTAL COMPARISON.
California Univ., Davis. Div. of Environmental Studies.
J. J. Elser, H. J. Carney, and C. R. Goldman.
Hydrobiologia HYDRB8, Vol. 200/201, p 69-82, August 27, 1990. 6 fig, 2 tab, 69 ref. NSF Grant BSR-8801084.

Descriptors: *Algal control, *Biocontrol, *Biomanipulation, *Lake restoration, *Limnology, *Plankton, *Trophic level, Biomass, Bioremediation, California, Castle Lake, Clear Lake, Daphnia, Eutrophic lakes, Food habits, Lake Tahoe, Oligotrophic lakes, Phytoplankton, Zooplankton.

An experimental study was conducted to compare algal responses to short-term biomanipulations of zooplankton in three California lakes that encompass a broad range of productivity (ultra-oligotrophic Lake Tahoe, mesotrophic Castle Lake, and strongly eutrophic Clear Lake). To assess the potential strength of grazing in each lake, algal responses to a 16-fold range of zooplankton biomass were evaluated. Algal responses to Daphnia over a range of Daphnia densities from 1-16 animals/L were compared. Effects of both ambient grazers and Daphnia were strong in Castle Lake. However, neither ambient zooplankton nor Daphnia had much impact on phytoplankton in Clear Lake. In Lake Tahoe, no grazing impacts could be demonstrated for the ambient zooplankton, but Daphnia grazing had dramatic effects. These results indicate weak coupling between phytoplankton and zooplankton in Clear Lake and Lake Tahoe, which lie near opposite extremes of lake trophic status for most lakes. These observations, along with work reported by other researchers, suggest that linkages between zooplankton and phytoplankton may be weak in lakes with either extremely low or high productivity. Biomanipulation approaches to recover hypereutrophic lakes that aim only to alter zooplankton size structure may be less effective if algal communities are dominated by large, inedible phytoplankton taxa. (Author's abstract)
W91-03767

WHY DO CLADOCERANS FAIL TO CONTROL ALGAL BLOOMS.
Warsaw Univ. (Poland). Dept. of Hydrobiology.
For primary bibliographic entry see Field 5G.
W91-03768

STRUCTURAL AND GRAZING RESPONSES OF ZOOPLANKTON COMMUNITY TO BIOMANIPULATION OF SOME DUTCH WATER BODIES.
Limnologisch Inst., Nieuwersluis (Netherlands).
For primary bibliographic entry see Field 5G.
W91-03769

BIOMANIPULATION AND FOOD-WEB DYNAMICS: THE IMPORTANCE OF SEASONAL STABILITY.
Norsk Inst. for Vannforskning, Oslo.
B. A. Faafeng, D. O. Hessen, A. Brabrand, and J. P. Nilssen.
Hydrobiologia HYDRB8, Vol. 200/201, p 119-128, August 27, 1990. 4 fig, 2 tab, 23 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Food chains, *Lake restoration, *Limnology, *Norway, *Nutrients, *Seasonal stability, Biomass, Cyanophyta, Daphnia, Enclosures, Fish, Food habits, Lake management, Lakes, Long-term studies, Monitoring, Nitrogen, Phosphorus, Phytoplankton, Roach, Water quality management.

Responses of phytoplankton biomass were monitored in pelagic enclosures subjected to manipulations with nutrients (+N/P), planktivore roach (Rutilus rutilus), and large grazers (Daphnia) in 18 bags during spring, summer, and autumn in mesotrophic Lake Gjersjoen (Norway). In general, the seasonal effects on phytoplankton biomass were more marked than the effects of biomanipulation. Primary top-down effects of fish on zooplankton were conspicuous in all bags, whereas control of phytoplankton growth by grazing was observed only in the nutrient-limited summer situation. The effect of nutrient additions was pronounced in summer, less in spring and autumn; additions of fish gave the most pronounced effect in spring. The phytoplankton/zooplankton biomass ratio remained high (10-100) in bags with fish, with the highest ratios in combination with fertilization. The ratio decreased in bags without fish to < 2 in most bags, but real grazing control was observed only in bags with addition of Daphnia. No direct grazing effects were observed on the absolute or relative biomass of cyanobacteria (mainly Oscillatoria aghardhii). The share of cyanobacteria in total phytoplankton biomass was lowest in summer (7-26%), higher in spring (39-63%) and more than 90% in the autumn experiment. The development of the cyanobacterial biomass was rather synchronous in all bags in all the three experiments. A high biomass of Daphnia gave no increase in the pool of dissolved nutrients in spring, a slight increase in summer and a pronounced increase in autumn. While a strong decrease in the P/C-cell quota of the phytoplankton was observed from spring to autumn, no effect of grazing or nutrient release could be related to this P/C status. The experiments indicate that such systems, with high and stable densities of inedible cyanobacteria, are rather insensitive to short-term (3-4 wk) biomanipulation efforts. This is supported by observations on the long-term development of the lake. (Author's abstract)
W91-03770

IMPACT OF WHITEFISH ON AN ENCLOSURE ECOSYSTEM IN A SHALLOW EUTROPHIC LAKE: SELECTIVE FEEDING OF FISH AND PREDATION EFFECTS ON ZOOPLANKTON COMMUNITIES.
National Inst. for Environmental Studies, Tsukuba (Japan). Environmental Biology Div.
T. Hanazato, T. Iwakuma, and H. Hayashi.
Hydrobiologia HYDRB8, Vol. 200/201, p 129-140, August 27, 1990. 4 fig, 2 tab, 41 ref. Ministry of Education, Science and Culture, Japan, Grants-in-Aid for Special Project Research 60129034 and 61134044.

Descriptors: *Eutrophic lakes, *Lake management, *Limnology, *Predation, Biomanipulation, Bioremediation, Crustaceans, Ecosystems, Enclosures, Food habits, Midges, Performance evaluation, Rotifers, Whitefish, Zooplankton.

Bag-type enclosures (75 cu m) with bottom sheets and tube-type enclosures (105 cu m), open to the bottom sediment, were stocked with exotic white-

fish (Coregonus lavaretus maraena) to study their predation effects on the plankton community. The fish fed mainly on adult chironomids during the period of their emergence (earlier part of the experimental period). Thereafter, the food preference was shifted to larvae of chironomids and crustacean zooplankters. The predation effects on the plankton community were not evident in the bag-type enclosures where zooplankton densities were consistently low. The fish reduced the crustacean populations composed of Bosmina fatalis, B. longirostris, and Cyclops vicinus, in the tube-type enclosures where the prey density was high (above ca. 50 individuals/L). The results suggested that the intensity of predation depended on the prey density. Rotifers increased in the fish enclosure, probably because Coregonus reduced the predation pressure by Cyclops vicinus on rotifers and allowed the latter to increase. In the fish enclosures no marked changes in species composition were observed. Zooplankton predated by the fish seemed to be distributed near the walls of the enclosures. Enclosure experiments for examining the effects of fish predation on pelagic zooplankton communities have various problems, such as changing the feeding habits of fish. (See also W91-03772) (Author's abstract)
W91-03771

IMPACT OF WHITEFISH ON AN ENCLOSURE ECOSYSTEM IN A SHALLOW EUTROPHIC LAKE: CHANGES IN NUTRIENT CONCENTRATIONS, PHYTOPLANKTON AND ZOOBENTHOS.
National Inst. for Environmental Studies, Tsukuba (Japan). Environmental Biology Div.
T. Iwakuma, H. Hayashi, I. Yasuda, T. Hanazato, and K. Takada.
Hydrobiologia HYDRB8, Vol. 200/201, p 141-152, August 27, 1990. 6 fig, 1 tab, 45 ref. Ministry of Education, Science and Culture, Japan, Grants-in-Aid for Special Project Research 60129034 and 61134044.

Descriptors: *Eutrophic lakes, *Japan, *Lake Suwa, *Lake management, *Limnology, Benthos, Biomanipulation, Bioremediation, Crustaceans, Ecosystems, Enclosures, Food habits, Midges, Performance evaluation, Rotifers, Whitefish, Zooplankton.

Large bag-type (75 cu m) and tube-type (105 cu m) enclosures were set up in the shallow, eutrophic Lake Suwa (Japan) and were each stocked with exotic planktivorous whitefish (Coregonus lavaretus maraena). The release of whitefish caused an increase in nutrient concentration in the tube-type enclosure whereas no such increase was observed in the bag-type enclosure. Bottom sediment seemed to be an important source of chironomid food for whitefish. The proportion of phytoplankton measuring < 10 micrometer and 20-40 micrometer, which respectively corresponded to Ochromonas species and Cryptomonas species, was lower in the fish enclosures than in the control, which might have been caused by high grazing pressure by rotifers. The predation by whitefish might have affected the species composition of phytoplankton through reducing copepod predation on rotifers, not through reducing the densities of cladocerans which directly feed on phytoplankton as many investigators have reported. The phytoplankton biomass was not affected much by the release of fish. Possible reasons are that the increase in density of rotifers reduced the biomass of available phytoplankton and that inedible Cyanophyceae were in the decreasing phase of their seasonal succession and could not increase successfully in spite of elevated nutrient levels. (See also W91-03771) (Author's abstract)
W91-03772

FADING RECOVERY: THE ROLE OF ROACH (RUTILUS RUTILUS L.) IN MAINTAINING HIGH PHYTOPLANKTON PRODUCTIVITY AND BIOMASS IN LAKE VESIJARVI, SOUTHERN FINLAND.
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
For primary bibliographic entry see Field 5G.
W91-03773

BOTTOM-UP EFFECTS OF BREAM (ABRAMIS BRAMA L.) IN LAKE BALATON.
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
I. Tatrai, G. Toth, J. E. Ponyi, J. Zlinskzky, and V. Istvanovics.
Hydrobiologia HYDRB8, Vol. 200/201, p 167-175, August 27, 1990. 9 fig, 3 tab, 17 ref.

Descriptors: *Algal control, *Food chains, *Hungary, *Lake Balaton, *Lake restoration, *Limnology, Bacteria, Bream, Crustaceans, Eutrophic lakes, Fish, Phytoplankton, Trophic level, Water quality management.

Enclosures (17 cu m) were used in the mesotrophic area of Lake Balaton (Hungary) to determine the impact of benthivorous bream (Abramis brama L.) on the lower trophic levels during the summers of 1984-1986. In enclosures with a fish biomass similar to the biomass in the eutrophic area of the lake, the number of phytoplankton species was highest. In enclosures with a low fish biomass, the phytoplankton was dominated by the greens. A high biomass of bream in the mesotrophic basin caused bacterial production corresponding to that of the eutrophic part of the lake. Crustaceans were dominated by copepods and were unable to control phytoplankton peaks. Bottom-up effects of bream were more obvious than top-down effects and seem to be more important in the possible control of water quality. (Author's abstract)
W91-03774

APPLICABILITY OF PLANKTONIC BIOMANIPULATION FOR MANAGING EUTROPHICATION IN THE SUBTROPICS.
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
For primary bibliographic entry see Field 5G.
W91-03775

CONDITIONS FOR EFFECTIVE BIOMANIPULATION: CONCLUSIONS DERIVED FROM WHOLE-LAKE EXPERIMENTS IN EUROPE.
Technische Univ., Dresden (German D.R.). Sektion Wasserwesen.
For primary bibliographic entry see Field 5G.
W91-03776

FISH MANIPULATION AS A LAKE RESTORATION TOOL IN SHALLOW, EUTROPHIC TEMPERATE LAKES: 1. CROSS-ANALYSIS OF THREE DANISH CASE-STUDIES.
National Environmental Research Inst., Silkeborg (Denmark). Div. of Freshwater Ecology.
For primary bibliographic entry see Field 5G.
W91-03777

FISH MANIPULATION AS A LAKE RESTORATION TOOL IN SHALLOW, EUTROPHIC, TEMPERATE LAKES 2: THRESHOLD LEVELS, LONG-TERM STABILITY AND CONCLUSIONS.
National Environmental Research Inst., Silkeborg (Denmark). Div. of Freshwater Ecology.
For primary bibliographic entry see Field 5G.
W91-03778

PHYTOPLANKTON BIOMASS REDUCTION AFTER PLANKTIVOROUS FISH REDUCTION IN A SHALLOW, EUTROPHIC LAKE: A COMBINED EFFECT OF REDUCED INTERNAL P-LOADING AND INCREASED ZOOPLANKTON GRAZING.
National Environmental Research Inst., Silkeborg (Denmark). Div. of Freshwater Ecology.
For primary bibliographic entry see Field 5G.
W91-03779

ECOLOGICAL CONSEQUENCES OF A MANUAL REDUCTION OF ROACH AND BREAM IN A EUTROPHIC, TEMPERATE LAKE.
Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.
For primary bibliographic entry see Field 5G.
W91-03780

PREDICTABILITY AND POSSIBLE MECHANISMS OF PLANKTON RESPONSE TO REDUCTION OF PLANKTIVOROUS FISH.
Oslo Univ. (Norway). Dept. of Limnology.
For primary bibliographic entry see Field 5G.
W91-03781

OLIGOTROPHICATION AS A RESULT OF PLANKTIVOROUS FISH REMOVAL WITH ROTENONE IN THE SMALL, EUTROPHIC, LAKE MOSVATN, NORWAY.
Rogalandsforskning, Stavanger (Norway). Aquaculture and Water Research Group.
For primary bibliographic entry see Field 5G.
W91-03782

WHOLE-LAKE FOOD-WEB MANIPULATION AS A MEANS TO STUDY COMMUNITY INTERACTIONS IN A SMALL ECOSYSTEM.
Water Board of Utrecht (Netherlands).
E. van Donk, M. P. Grimm, R. D. Gulati, and J. P. G. Klein Breteler.
Hydrobiologia HYDRB8, Vol. 200/201, p 275-289, August 27, 1990. 5 fig, 4 tab, 42 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Food chains, *Lake management, *Lake restoration, *Limnology, *The Netherlands, *Water quality control, Chlorophyll a, Chlorophyta, Cyanophyta, Denitrification, Lake Zwemlust, Macrophytes, Nitrogen, Nutrients, Phosphorus, Phytoplankton, Public health, Recreation, Snails, Submerged plants, Swimming, Trophic level, Zooplankton.

Whole-lake food web manipulation was carried out in the hypertrophic Lake Zwemlust (The Netherlands) to study the effects on the lake's trophic status and to gain an insight into complex interactions among lake communities. Before manipulation this small (1.5 ha) and shallow (1.5 m) lake was characterized by Microcystis blooms in summer and high chlorophyll-a concentrations were common (about 250 microgram/L). In March 1987 the planktivorous and benthivorous fish species in the lake were completely removed, a new simple fish community (pike and rudd) was introduced, and artificial refuges were created. Light, climate, nutrient concentrations, phytoplankton, zooplankton, fish, macrophytes, and macrofauna were monitored during 1987, 1988, and 1989. After the manipulation, despite the still high P and N loads to the lake (about 2.2 g P/sq m/yr and about 5.3 g N/sq m/yr), the phytoplankton density was low (chlorophyll-a < 5 microgram/L), due to control by large zooplankton in spring and N-limitation in summer and autumn. A marked increase in the abundance of macrophytes and filamentous green algae in 1988 and 1989, as well as N loss due to denitrification, contributed to the N limitation of the phytoplankton. Before manipulation no submerged macro-vegetation was present, but in 1988, about 50% of the lake bottom was covered by macrophytes, increasing to 80% in 1989. This led to substantial accumulation of both N and P, namely 76% and 73%, respectively, of the total nutrients in the lake in particulate matter. The increase in macrophytes caused: (1) direct nuisance to swimmers and (2) the large-scale development of snails, especially Lymnaea peregra, which may harbor the parasite causing 'swimmers' itch.' Harvesting only about 3% of the total macrophyte biomass from the swimmers' area, twice a year, reduced this nuisance without adversely affecting the water clarity. (Author's abstract)
W91-03783

FIRST ATTEMPT TO APPLY WHOLE-LAKE FOOD-WEB MANIPULATION ON A LARGE SCALE IN THE NETHERLANDS.
Water Board of Utrecht (Netherlands).
For primary bibliographic entry see Field 5G.
W91-03784

IS REDUCTION OF THE BENTHIVOROUS FISH AN IMPORTANT CAUSE OF HIGH TRANSPARENCY FOLLOWING BIOMANIPULATION IN SHALLOW LAKES.
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
M. L. Meijer, M. W. de Haan, A. W. Breukalaar, and H. Buiteveld.
Hydrobiologia HYDRB8, Vol. 200/201, p 303-315, August 27, 1990. 9 fig, 2 tab, 36 ref.

Descriptors: *Algal control, *Biocontrol, *Biomanipulation, *Fish management, *Lake restoration, *Limnology, *Netherlands, *Suspended sediments, *Transparency, Algae, Biomass, Bioremediation, Chlorophyll a, Detritus, Fish, Model studies, Shallow water, Turbidity.

Experimental reduction of the fish stock in two shallow lakes in The Netherlands shows that such a biomanipulation can lead to a substantial increase in transparency, which is caused not only by a decrease in algal biomass, but by a decrease in resuspended sediment and detritus. A model was developed to describe transparency in relation to chlorophyll-a and inorganic, suspended solids (resuspended sediment). The use of this model showed that more than 50% of the turbidity in these shallow lakes before biomanipulation was determined by sediment resuspension, mainly caused by benthivorous fish. Another analysis reveals that the concentration of inorganic suspended solids and the biomass of benthivorous fish are positively correlated, and that even in the absence of algae a benthivorous fish biomass of 600 kg/ha can reduce the Secchi depth to 0.4 m in shallow lakes. In addition, algal biomass also appeared to be reduced indirectly by removal of benthivorous fish. Reduction of benthivorous fish is necessary to get macrophytes and macrophytes seem necessary to keep the algal biomass low in nutrient-rich shallow lakes. It is concluded that the impact of benthivorous fish on the turbidity can be large, especially in shallow lakes. (Author's abstract)
W91-03785

EARLY RESPONSES OF PLANKTON AND TURBIDITY TO BIOMANIPULATION IN A SHALLOW WATER PRAIRIE LAKE.
North Dakota State Univ., Fargo. Dept. of Zoology.
For primary bibliographic entry see Field 5G.
W91-03786

EFFECTS OF PLANKTIVOROUS FISH MASS MORTALITY ON THE PLANKTON COMMUNITY OF LAKE MENDOTA, WISCONSIN: IMPLICATIONS FOR BIOMANIPULATION.
Wisconsin Univ.-Madison. Center for Limnology.
M. J. Vanni, C. Luecke, J. F. Kitchell, and J. J. Magnuson.
Hydrobiologia HYDRB8, Vol. 200/201, p 329-336, August 27, 1990. 2 fig, 1 tab, 17 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Fishkill, *Lake restoration, *Limnology, *Plankton, Daphnia, Lake Mendota, Lake management, Nutrients, Phosphorus, Phytoplankton, Seasonal distribution, Wisconsin, Zooplankton.

Massive mortality of planktivorous fish had a dramatic impact on plankton community dynamics of Lake Mendota, Wisconsin. After fish mortality, the larger Daphnia pulicaria replaced the smaller Daphnia galeata mendotae, resulting in greater grazing pressure on the phytoplankton. This was accomplished by a much longer spring clear-water period and lower summer phytoplankton biomass compared to years before the fish mortality. Analysis of historical data (from the mid-1970s) showed that previous fluctuations in planktivorous abundance had similar effects on Daphnia abundance and species composition and on summer phytoplankton biomass. However, the mid-1970s fish fluctuations had no detectable effect on summer phytoplankton. Concentrations of P were much higher in the 1970s (spring P 80-135 microgram/L) than in the 1980s (spring P 19-36 microgram/L) and it is possible that high P concentrations may reduce trophic cascade effects on summer phytoplankton communities. This suggests that the success of biomanipulation programs may depend on lake nutrient status. (Author's abstract)
W91-03787

EFFECTS OF PLANKTIVORE ABUNDANCE ON CHLOROPHYLL-A AND SECCHI DEPTH.
York Univ., North York (Ontario). Dept. of Biology.
D. J. McQueen, M. R. S. Johannes, N. R. Lafontaine, A. S. Young, and E. Longbotham.
Hydrobiologia HYDRB8, Vol. 200/201, p 337-341, August 27, 1990. 3 fig, 1 tab, 28 ref.

Descriptors: *Biocontrol, *Food chains, *Limnology, *Transparency, Chlorophyll a, Fish, Fish diets, Lake management, Nutrients, Phosphorus, Statistics.

Two analyses were used to test the hypothesis that planktivore abundances contribute to the residual variation of Secchi depth or chlorophyll-a plotted with respect to mean summer epilimnetic total P. The first analysis involved 15 lake years of data from six lakes. The data set comprised mark-recapture assessment of piscivore and planktivore numbers and estimates of mean summer chlorophyll-a, total P, and Secchi depth. Residual chlorophyll-a variation was not significantly ($p > 0.05$) correlated with planktivore densities, but planktivore densities did contribute ($p < 0.02$) to the residual variation of Secchi depth on mean total P. The second analysis included all of the data used in the first analysis plus an additional 13 lake years of data from the literature. These data showed that the percentage of the total fish community comprising planktivores did not contribute significantly ($p > 0.05$) to the residual variation in chlorophyll-a with respect to mean summer total P. Together, these results suggest that planktivore abundance has a significant cascading impact on water clarity, but no longer term statistically significant impact on mean summer chlorophyll-a concentrations. (Author's abstract)
W91-03788

FACTORS RELATED TO VARIANCE OF RESIDUALS IN CHLOROPHYLL-TOTAL PHOSPHORUS REGRESSIONS IN LAKES AND RESERVOIRS IN ARGENTINA.
Instituto Nacional de Investigacion y Desarrollo Pesquero, Mar del Plata (Argentina).
R. Quiros.
Hydrobiologia HYDRB8, Vol. 200/201, p 343-355, August 27, 1990. 4 fig, 5 tab, 55 ref. Consejo Nacional de Investigaciones Cientificas y Tecnicas Grant PID 3-017400/85.

Descriptors: *Argentina, *Chlorophyll, *Limnology, *Phosphorus, *Primary productivity, Biomass, Dissolved oxygen, Fish, Food chains, Lakes, Macrophytes, Plankton, Regression analysis, Reservoirs, Sediment-water interfaces, Statistical analysis, Submerged plants, Zooplankton.

Data from an extensive mid-summer survey of Argentinian lakes and reservoirs were used to study the effects of variability in internal processes on the residual variance in chlorophyll-total phosphorus (CHL-TP) regression models. These effects were compared with those related to the external characteristics of lakes, e.g., climate, morphometry, and nutrient status. Zooplanktivorous fish biomass, mean macrozooplankton size, dissolved oxygen at the sediment-water interface, and submersed macrophyte development, were shown to be significant in explaining residual variance in CHL-TP for Argentinian lakes and reservoirs. The results suggest that those variables have discontinuous or threshold effects on CHL-TP residuals among lakes. Significant differences also were shown between CHL-TP regressions for lakes with and without zooplanktivorous fish and for lakes with small or large macrozooplankton. Lakes with zooplanktivorous fish, small body size macrozooplankton, and very low hypolimnetic oxygen also have higher chlorophyll levels than predicted from CHL-TP regression models. (Author's abstract)
W91-03789

THREE YEARS OF EXPERIENCE IN BIOMANIPULATING A SMALL EUTROPHIC LAKE: LAGO DI CANDIA (NORTHERN ITALY).
Istituto Italiano di Idrobiologia, Pallanza (Italy).
For primary bibliographic entry see Field 5G.
W91-03790

ENGINEERING AND BIOLOGICAL APPROACHES TO THE RESTORATION FROM EUTROPHICATION OF SHALLOW LAKES IN WHICH AQUATIC PLANT COMMUNITIES ARE IMPORTANT COMPONENTS.
Liverpool Univ. (England). Dept. of Environmental and Evolutionary Biology.
For primary bibliographic entry see Field 5G.
W91-03791

POTENTIAL OF ARTIFICIAL REFUGIA FOR MAINTAINING A COMMUNITY OF LARGE-BODIED CLADOCERA AGAINST FISH PREDATION IN A SHALLOW EUTROPHIC LAKE.
University of East Anglia, Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 5G.
W91-03792

ECOSYSTEM DEVELOPMENT IN DIFFERENT TYPES OF LITTORAL ENCLOSURES.
Agricultural Univ., Wageningen (Netherlands). Dept. of Nature Conservation.
J. E. Vermaat, M. J. M. Hootsmans, and G. M. van Dijk.
Hydrobiologia HYDRB8, Vol. 200/201, p 391-398, August 27, 1990. 7 fig, 1 tab, 27 ref.

Descriptors: *Aquatic plants, *Biocontrol, *Biomanipulation, *Enclosures, *Lake restoration, *Limnology, *Macrophytes, *Netherlands, Biomass, Bioturbation, Chara, Daphnia, Fish, Lake Veluwe, Potamogeton, Rotifers, Sediments, Seston.

Macrophyte growth was studied in two enclosure types (gauze and polythene) in a homogeneous Potamogeton pectinatus bed in Lake Veluwe (The Netherlands). The gauze was expected to allow for sufficient exchange within the lake to maintain similar seston densities, whereas the polythene was expected to exclude fish activity and most water exchange. Polythene enclosures held higher P. pectinatus biomass (ash-free dry weight, AFDW) than the lake, and gauze enclosures were intermediate. The enclosures had a higher abundance of other macrophyte species (Chara sp., Potamogeton pusillus) than the lake. Seston ash content was not decreased, but seston AFDW and periphyton ash content and AFDW were lower in polythene than in gauze enclosures. The difference in plant biomass between gauze and polythene may be attributed to a difference in periphyton density and in seston AFDW due to zooplankton grazing; rotatoria and Daphnia densities were higher in polythene enclosures. Since seston and periphyton AFDW and ash content were similar in lake and gauze enclosures, the intermediate macrophyte biomass in the gauze enclosures may be explained by reduced wave action and mechanical stress. Alternatively, phytoplankton inhibition by allelopathic excretions from the macrophytes may have caused the high macrophyte biomass in the polythene, and an absence of sediment-disturbing fish the intermediate biomass in the polythene, and an absence of sediment-disturbing fish the intermediate biomass in the gauze enclosures. Creation of sheltered areas may favor macrophyte growth through both mechanisms. It is concluded that this can be an important tool in littoral biomanipulation. (Author's abstract)
W91-03793

CAN MACROPHYTES BE USEFUL IN BIOMANIPULATION OF LAKES: THE LAKE ZWEMLUST EXAMPLE.
Warsaw Univ. (Poland). Dept. of Hydrobiology.
For primary bibliographic entry see Field 5G.
W91-03794

BIOMANIPULATION OF LAGO DI CANDIA (NORTHERN ITALY): A THREE-YEAR EXPERIENCE OF AQUATIC MACROPHYTE MANAGEMENT.
Istituto Italiano di Idrobiologia, Pallanza (Italy).
For primary bibliographic entry see Field 5G.
W91-03795

IMPACT OF MECHANICAL DEWEEDING ON DAL LAKE ECOSYSTEM.
Kashmir Univ., Srinagar (India). Centre of Research for Development.
For primary bibliographic entry see Field 5G.
W91-03796

PROPOSALS FOR MACROPHYTE RESTORATION IN EUTROPHIC COASTAL LAGOONS.
Barcelona Univ. (Spain). Dept. de Ecologia.
For primary bibliographic entry see Field 5G.
W91-03797

ZEBRA MUSSELS (DREISSENA POLYMORPHA): A NEW PERSPECTIVE FOR WATER QUALITY MANAGEMENT.
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
For primary bibliographic entry see Field 5G.
W91-03798

SHOALS OF DREISSENA POLYMORPHA AS A BIO-PROCESSOR OF SESTON.
Nicholas Copernicus Univ. of Torun (Poland). Inst. of Biology.
For primary bibliographic entry see Field 5G.
W91-03799

EVALUATION OF CHAOBORUS PREDATION ON NATURAL POPULATIONS OF HERBIVOROUS ZOOPLANKTON IN A EUTROPHIC LAKE.
Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.
K. Christoffersen.
Hydrobiologia HYDRB8, Vol. 200/201, p 459-466, August 27, 1990. 5 fig, 2 tab, 30 ref. National Science Research Council (Denmark) Grant 11-6934.

Descriptors: *Biomanipulation, *Eutrophic lakes, *Food chains, *Lake management, *Lake restoration, *Limnology, *Predation, *Zooplankton, Daphnia, Denmark, Enclosures, Frederiksborg Slotsso, Migration, Seasonal variation.

The effect of Chaoborus predation on natural zooplankton communities was tested in enclosure experiments during June, July, and August in the eutrophic Frederiksborg Slotsso, Denmark. Natural densities of Chaoborus larvae in enclosures reduced the abundance of copepod nauplii and Chydorus sphaericus up to 60% and 80%, respectively, compared with controls. In contrast, Chaoborus was not able to suppress populations of Eudiaptomus graciloides Daphnia cucullata. Predation was strongest during June and decreased thereafter as Chaoborus pupae emerged. Laboratory experiments showed that a considerable part (20-30% of the population/day) of Chaoborus larvae emerged as pupae at 18-20 C in July and August. Chaoborous larvae occurred in the lake as migratory individuals from May to September with mean population densities of about 100 larvae/sq m. Results from the enclosure experiments suggest that the populations of herbivorous zooplankton in Frederiksborg Slotsso during June, July, and August are not controlled by natural populations of Chaoborous. (Author's abstract)
W91-03800

HYDROPHYTE-MACROINVERTEBRATE INTERACTIONS IN ZWEMLUST, A LAKE UNDERGOING BIOMANIPULATION.
Akademia Rolnicza, Lublin (Poland). Dept. of Zoology and Hydrobiology.
For primary bibliographic entry see Field 5G.
W91-03801

MULTIPLICITY OF STABLE STATES IN FRESHWATER SYSTEMS.
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
M. Scheffer.
Hydrobiologia HYDRB8, Vol. 200/201, p 475-486, August 27, 1990. 8 fig, 28 ref.

Descriptors: *Biomanipulation, *Bioremediation, *Ecosystems, *Lake restoration, *Lakes, *Limnology, *Model studies, Eutrophication, Nutrients, Water pollution treatment.

The presence of multiple equilibria in an ecosystem can cause the system to show hysteresis or sudden jumps, rather than responding smoothly to changes in external factors. The properties have important implications for management of such systems. Minimal models were employed to show that several ecological relationships in freshwater systems potentially give rise to the existence of alternative equilibria over a certain range of nutrient values. An important consequence is that signs of eutrophication are apparent only after the occurrence of changes that are very difficult to reverse. Reduction of the nutrient level as a measure to restore such systems gives poor results, but biomanipulation as an additional measure can have significant effects, provided that the nutrient level has been reduced enough to allow the existence of a stable alternative clear water equilibrium. (Author's abstract)
W91-03802

QUANTIFYING THE FOOD WEBS OF LAKE BLEISWIJKSE ZOOM AND LAKE ZWEMLUST.
Waterloopkundig Lab. te Delft (Netherlands).
A. H. Bakema, W. J. Rip, M. W. de Haan, and F. J. Los.
Hydrobiologia HYDRB8, Vol. 200/201, p 487-495, August 27, 1990. 3 fig, 2 tab, 13 ref.

Descriptors: *Biocontrol, *Biomass, *Computer models, *Food chains, *Limnology, *Model studies, *Netherlands, Biomanipulation, Detritus, Diets, Lake Bleiswijkse Zoom, Lake Zwemlust, Trophic level.

Data on biomass levels from two lakes in the Netherlands, Lake Bleiswijkse Zoom and Lake Zwemlust, on which biomanipulation experiments are being carried out, were compared with some physiological properties of the species present at different trophic levels. These properties include the daily ration and metabolic fraction of heterotrophic species, natural mortality rate and autolysis fraction of primary producers, rate of detritus mineralization, and digestibility of all species. Mean biomass levels during the year were calculated directly from measurements. These combined data were used to see if a consistent description of the food web could be produced, by letting a computer model search for a balanced food web that corresponds most closely to the measurements. The computer model relates the present biomass of species at different trophic levels, by constructing balance equations for the amount of biomass present at each trophic level, using the physiological properties of the species. Results include estimates of production levels, diet composition, and detritus production for species at all trophic levels. (Author's abstract)
W91-03803

BIOMANIPULATION ADDITIONAL TO NUTRIENT CONTROL FOR RESTORATION OF SHALLOW LAKES IN THE NETHERLANDS.
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
For primary bibliographic entry see Field 5G.
W91-03804

BIOMANIPULATION DEVELOPMENT IN NORWAY.
Direktoratet for Vilt og Ferskvannsfisk, Trondheim (Norway).
For primary bibliographic entry see Field 5G.
W91-03805

REVIEW: LIMNOLOGICAL MANAGEMENT AND BIOMANIPULATION IN THE LONDON RESERVOIRS.
Royal Holloway and Bedford New Coll., Egham (England). Dept. of Biology.
For primary bibliographic entry see Field 5G.
W91-03806

POTENTIAL FOR BIOMANIPULATION USING FRY COMMUNITIES IN A LOWLAND RESERVOIR: CONCORDANCE BETWEEN WATER QUALITY AND OPTIMAL RECRUITMENT.
Lodz Univ. (Poland). Inst. of Environmental Biology.
For primary bibliographic entry see Field 5G.
W91-03807

RESTORATION OF SHALLOW EUTROPHIC LAKES, AND THE ROLE OF NORTHERN PIKE, AQUATIC VEGETATION, AND NUTRIENT CONCENTRATION.
Witteveen and Bos, Deventer (Netherlands).
For primary bibliographic entry see Field 5G.
W91-03808

EFFECTS OF PLANKTIVOROUS FISHES ON THE PLANKTON COMMUNITY IN A EUTROPHIC LAKE.
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
T. Miura.
Hydrobiologia HYDRB8, Vol. 200/201, p 567-579, August 27, 1990. 3 fig, 4 tab, 27 ref. Japanese Ministry of Education, Science, and Culture Grants-in-Aid 58041037, 59043033, 60041038, 61043034, 62041050, and 63043038.

Descriptors: *Biocontrol, *Biomanipulation, *China, *Eutrophic lakes, *Food chains, *Lake restoration, *Limnology, Carp, Chlorophyll a, Chlorophyta, Computer models, Cyanophyta, Donghu Lake, East Lake, Ecosystems, Model studies, Phytoplankton, Zooplankton.

Stocking silver carp, a phytoplankton feeder, and bighead carp, an omnivorous plankton feeder, at high densities in a eutrophic lake (East Lake or Donghu Lake, China) caused a dramatic change in the lake ecosystem. Microcystis, which had been dominant in summer and a main food of the fishes, decreased markedly and green algae smaller than 10 micrometers then became dominant. Chlorophyll-a per unit area decreased slightly, while the rate of production was higher than in previous years. As the total density of the fishes increased (0.09 to 0.11 fish/sq m), the growth of silver carp was retarded, whereas that of bighead carp increased. Microcystis was unable to become dominant due to increased grazing pressure by the fishes, and small green algae became dominant. The lake conditions became more favorable for zooplankters, which selectively consumed small green algae, and accordingly, the production of zooplankton rose. Bighead carp consumed more animal food, which they assimilate at a higher rate than plant food, and grew better in spite of the fact that the fish density increased. The feeding rate of silver carp was greatly reduced because the green algae were too small to ingest, and the fish therefore grew poorly. Results of a computer simulation of a model consisting of five compartments, representing the blue-green algae, green algae, zooplankton, silver carp, and bighead carp, support the food web change observed in the lake. (Author's abstract)
W91-03809

EXPERIMENTAL STUDY OF THE IMPACTS OF PLANKTIVOROUS FISHES ON PLANKTON COMMUNITY AND EUTROPHICATION OF A TROPICAL BRAZILIAN RESERVOIR.
Companhia de Agua e Esgotos de Brasilia (Brazil). Secao de Estudos de Poluicao Hidrica.
For primary bibliographic entry see Field 5G.
W91-03810

SOME POSITIVE AND NEGATIVE EFFECTS OF STOCKING WHITEFISH ON THE ECOSYSTEM REDEVELOPMENT OF HJARBAEK FJORD, DENMARK.
Viborg Amtskommune (Denmark). Environmental Dept.
For primary bibliographic entry see Field 5G.
W91-03811

ZOOPLANKTON IMPACTS ON CHLOROPHYLL AND TRANSPARENCY IN ONONDAGA LAKE, NEW YORK.
Michigan Technological Univ., Houghton. Dept. of Civil and Environmental Engineering.
M. T. Auer, M. L. Storey, S. W. Effler, N. A. Auer, and P. Sze.
Hydrobiologia HYDRB8, Vol. 200/201, p 603-617, August 27, 1990. 8 fig, 47 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Lake restoration, *Limnology, *Onondaga Lake, *Phytoplankton, *Transparency, *Zooplankton, Algae, Chlorophyll, Crustaceans, Fish, Food chains, New York, Phosphorus, Seasonal distribution.

The transparency of polluted, hypereutrophic Onondaga Lake, New York, has improved substantially in the late 1980s as a result of reductions in phytoplankton biomass in the absence of significant reductions in external phosphorus loading. Much of this improvement has been due to the occurrence of clearing events, e.g., sudden and dramatic increases in transparency. Field measurements, laboratory experiments, and modelling analyses were employed to identify processes regulating phytoplankton standing crop during the spring to fall interval of 1987. Changes in the zooplankton community documented over the past decade support the conclusion that increased zooplankton grazing has contributed to improvements in transparency. Herbivores now represent a greater fraction of the zooplankton population and more efficient cladocerans are present in greater numbers. Biomanipulation practices designed to reduce the abundance of planktivorous fish in Onondaga Lake, e.g., reestablishment of piscivorus species, may reduce pressure on the grazing community and thus result in further improvements in transparency. (Author's abstract)
W91-03812

RESPONSES OF PERIPHYTON TO CHANGES IN CURRENT VELOCITY, SUSPENDED SEDIMENT AND PHOSPHORUS CONCENTRATION.
Washington Univ., Seattle. Dept. of Civil Engineering.
R. R. Horner, E. B. Welch, M. R. Seeley, and J. M. Jacoby.
Freshwater Biology FWBLAB, Vol. 42, No. 2, p 215-232, October 1990. 10 fig, 2 tab, 43 ref. NSF Grant CEE-8304731.

Descriptors: *Algae, *Current velocity, *Limiting nutrients, *Limnology, *Nutrients, *Periphyton, *Phosphorus, *Stream ecology, *Suspended sediments, Biomass, Chlorophyta, Community structure, Cyanophyta, Diatoms.

Research was performed in laboratory streams to evaluate periphytic biomass accrual, export, and community composition over a range of limiting nutrient (phosphorus) concentrations with variable velocity, and suspended sediment addition, in comparison to constant velocity and no suspended sediment. In fixed-velocity treatments, a velocity increase to 60 cm/s significantly enhanced biomass accrual, but further increases resulted in substantial biomass reduction. Diatoms were favored at relatively high velocities and low phosphorus concentrations, whereas the blue-green Phormidium tended to dominate at higher soluble reactive phosphorus (SRP) concentrations and the green Mougeotia seemed to prefer lower velocities. Sudden increases in velocity raised instantaneous loss rates by an order of magnitude or more, but these high rates persisted only briefly. As a result, marked biomass reductions were not apparent a day after the velocity change. Dominance changes from filamentous green or blue-green to diatoms immediately after the increase were reversed within two days. Loss rate increases due to solids addition were much smaller than those accompanying velocity increases, but simultaneous velocity elevation and solids addition produced instantaneous loss rates approximately double those with velocity increases alone. Areal uptake rates of P by algae growing in the laboratory streams increased with SRP concentrations up to approximately 15 microg/L in overlying water. They also increased above 35 cm/s. Overall, uptake rate seemed to vary inversely with biomass. The results suggested that although nutrient uptake is primarily a surface phenomenon, diffusion to interior cells can also determine the responses of attached communities. Both diffusion and uptake rate were stimulated by increasing nutrient concentration and velocity up to certain levels, but became limited by biofilm thickness and scouring. (Author's abstract)
W91-03820

TOXICITY OF A SOLUBLE PEPTIDE FROM MICROCYSTIS SP. TO ZOOPLANKTON AND FISH.
Chile Univ., Santiago. Dept. de Biologia.
For primary bibliographic entry see Field 5C.
W91-03821

ZOOPLANKTON DISTRIBUTION IN RELATION TO TURBIDITY AND RELATED ENVIRONMENTAL GRADIENTS IN A LARGE SUBTROPICAL RESERVOIR: PATTERNS AND IMPLICATIONS.
Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
R. C. Hart.
Freshwater Biology FWBLAB, Vol. 42, No. 2, p 241-263, October 1990. 6 fig, 9 tab, 43 ref.

Descriptors: *Limnology, *Reservoirs, *South Africa, *Suspended sediments, *Turbidity, *Zooplankton, Copepods, Daphnia, Distribution patterns, Phytoplankton, Transparency.

The longitudinal abiotic and plankton gradients in Lake le Roux, a fjord-like reservoir on the Orange River, South Africa, and their probable causes and implications were examined. Secchi depth transparency doubled from approximately 18 cm at the turbid upper end, to 33 cm near the dam wall. On average, phytoplankton abundance, and total crustacean zooplankton biomass were lowest at the top of the lake, but reached maximal values within 15 km 'downstream,' reflecting the rapid development of plankton. The composition of crustacean zooplankton varied along the length of the reservoir. Both seasonal and inter-annual differences were evident. On average, however, cladocerans (Daphnia, Moina) were especially sparse in the more turbid, uppermost reaches, where advective effects of river inflows were most pronounced. The attainment of maximal zooplankton standing stocks some 15 km downstream was attributable to the proliferation particularly of the herbivorous copepod Metadiaptomus, along with minor increases in several cladoceran components. Metadiaptomus continued to increase downstream, in line with declining turbidity, although Daphnia and Moina reached their respective abundance maxima in central and lower reaches of the reservoir, reflecting slight disparities in response to turbidity or related gradients. By contrast, copepod abundance declined progressively downstream, perhaps reflecting longitudinal shifts in competitive balance between copepods and cladocerans. Certain of the taxa-specific distributions observed contrast with trends reported in other systems. However, the longitudinal distribution of total zooplankton abundance, the occurrence of maximal biomass in Lake le Roux in the region of river inflow matches the pattern reported for crustacean and rotiferan zooplankton in other reservoirs. The pattern observed in Lake le Roux suggests that turbid reservoirs may function as sinks rather than sources of organic matter. (White-Reimer-PTT)
W91-03822

SPECIES DISTRIBUTIONS AND SHELL CHARACTERISTICS OF PISIDIUM (MOLLUSCA: BIVALVIA) IN THE COLORADO FRONT RANGE: THE ROLE OF ABIOTIC FACTORS.
Colorado Univ. at Boulder. Center for Limnology.
J. F. Sounders, and G. W. Kling.
Freshwater Biology FWBLAB, Vol. 42, No. 2, p 275-285, October 1990. 2 fig, 6 tab, 55 ref.

Descriptors: *Acid rain effects, *Acidification, *Alkalinity, *Clams, *Colorado, *Distribution patterns, *Limnology, *Mollusks, *Mountain lakes, *Rocky Mountains, Bivalves, Colorado Front Range, Dissolved organic carbon, Hydrogen ion concentration, Water chemistry.

The relationships between water chemistry, species distributions, and shell characteristics of clams in lakes and ponds of the Colorado Front Range, the eastern-most unit of the Rocky Mountain system were investigated. During the summer (July-August) of 1983 and 1984, water samples were collected from forty lakes in the Colorado Front Range. This period coincides with seasonal stratification for the deeper lakes and is well past any pulse of water from snowmelt. The twenty-five lakes that contained clam populations were classified on the basis of water chemistry using discriminant analysis. Each lake belonged to a habitat type defined by the dominant Pisidium species. The analysis was used to identify chemical variables contributing most to this classification. Alkalinity, pH, and dissolved organic carbon contributed most to the classification of lakes according to the dominant Pisidium species. Alkalinity was also strongly correlated with mean clam weight for populations of P. casertanum, the most common of the five species collected. Historical evidence shows a reduction in the number of lakes occupied by clams and a constriction in the distributions of certain species. These changes have occurred mainly in lakes that now have low alkalinity. The reduction in the number of lakes supporting clam populations, and the constriction of distributions for certain species, suggests very strongly that the general suitability of clam habitats in the Front Range has declined recently. The mechanisms by which habitat quality has been reduced cannot be demonstrated conclusively. However, the results are suggestive of a role for acidification, because the loss of habitat and the disappearance of species coincides with a documented decrease in alkalinity. (White-Reimer-PTT)
W91-03823

SUCCESSIONAL CHANGES IN THE SOFT-WATER MACROPHYTE VEGETATION OF (SUB)ATLANTIC, SANDY, LOWLAND, REGIONS DURING THIS CENTURY.
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
G. H. P. Arts, G. Van der Velde, J. G. M. Roelofs, and C. A. M. Van Swaay.
Freshwater Biology FWBLAB, Vol. 42, No. 2, p 287-294, October 1990. 4 fig, 2 tab, 25 ref.

Descriptors: *Acid rain effects, *Acidification, *Aquatic plants, *Eutrophication, *Lake acidification, *Macrophytes, *Succession, *The Netherlands, Buffering, Historical changes, Organic matter, Quillworts, Sediments.

The most important properties which distinguish soft waters on sandy deposits in atlantic and subatlantic lowland parts of Western Europe from soft waters in other geographical regions are their small size, shallowness, original hydrological isolation and the occurrence of a relatively rich and abundant vegetation of soft-water macrophyte species. The Dutch soft waters are a representative group of these waters. In order to trace changes in soft waters in the Netherlands, sites where the isoetids Littorella uniflora, Lobelia dortmanna, Isoetes lacustris and/or I. echinospora were known to have been present in the past or where they are still found were studied. One hundred forty-six bodies of water with good historical records were selected for study. The significance of differences in sediment and water quality between groups of data was determined using the Kruskal-Wallis and Wilcoxon tests. The survey of the 146 water bodies during the period 1983-1986 revealed striking differences in aquatic vegetation. The most important abiotic changes during this century were an increase in the nutrient content of the water column

and an accumulation of organic matter in the sediment. The processes observed during this century are acidification, eutrophication and water hardening. Soft waters which exhibit a higher buffering capacity have changed under the influence of acidification or eutrophication or are still characterized by an often impoverished or eutrophicated soft-water vegetation. Very soft waters supporting isoetids do not exist any more, mainly because of acidification. As these waters are hydrologically isolated and mainly fed by rainwater and superficial groundwater, acidification may be attributed to the impact of atmospheric pollutants. It is thought that a nymphaeid vegetation of Nymphaea alba and Nuphar lutea may be the final stage of succession during acidification as well as eutrophication of soft waters. (White-Reimer-PTT)
W91-03824

QUANTITATIVE RELATIONSHIPS BETWEEN OLIGOCHAETE COMMUNITIES AND PHOSPHORUS CONCENTRATIONS IN LAKES.
Conservation de la Faune, Saint-Sulpice (Switzerland).
C. Lang.
Freshwater Biology FWBLAB, Vol. 42, No. 2, p 327-334, October 1990. 1 fig, 3 tab, 33 ref.

Descriptors: *Annelids, *Bioindicators, *Eutrophication, *Lakes, *Limnology, *Phosphorus, Community structure, Correlation analysis, Depth, Oligotrophic lakes, Trophic level.

The possibility of using tubificid and lumbriculid worm communities as indicators of trophic state and the factors, such as depth of sampling sites that can modify this relationship, was studied using data from eight Western European and three North American lakes. The relative abundance of oligotrophic species was related to phosphorus concentration. Mean annual concentrations of total phosphorus, recorded in the whole lake during the 5 years preceding the sampling of worms, were averaged and this mean was used to indicate the trophic state. The mean relative abundance (%) of oligotrophic species was negatively correlated with mean concentrations of total phosphorus. Relationships between worms and phosphorus were also modified by the depth of the area from which worms were sampled. The relative abundance of oligotrophic species decreased with increasing phosphorus more rapidly in the deepest area than in the whole lake. Thus, oligotrophic species disappeared from the deepest area at a lower phosphorus concentration than they did from the other areas. The predictable relationship existing between the structure of worm communities and phosphorus concentrations in the water of lakes demonstrates that worm communities are reliable indicators of trophic state. However, this relationship is only applicable to large and deep lakes which were oligotrophic some years ago. Furthermore, it can only be used if oligotrophic species persist in the profundal; that is, as long as the whole profundal does not become anoxic. (White-Reimer-PTT)
W91-03825

FIRE AND THE DYNAMICS OF ALLOCHTHONOUS DETRITUS IN A SOUTH AFRICAN MOUNTAIN STREAM.
Cape Town Univ. (South Africa). Dept. of Zoology.
D. L. Britton.
Freshwater Biology FWBLAB, Vol. 42, No. 2, p 347-360, October 1990. 5 fig, 1 tab, 37 ref.

Descriptors: *Detritus, *Forest fires, *Mountain streams, *Organic matter, *South Africa, *Stream ecology, Litter, Particulate matter, Seasonal variation, Sediments.

The effects of a late-summer prescribed burn on the regime of allochthonous input to a second-order mountain stream in the southwestern Cape, South Africa, and the consequent effects on standing stocks of benthic matter were studied. The input of allochthonous material, standing stocks of benthic organic matter (BOM) and suspended particulate organic matter (POM) were measured in the stream from March 1986 to February 1988. The surrounding fynbos-dominated catchment was subjected to a prescribed burn in March 1987. Litter-fall in the pre-burn year exhibited a distinct seasonal pattern, with peak falls during the early summer. Although the riparian canopy was not directly affected by the fire, in that it did not burn, a heavy, seasonal leaf-fall occurred shortly afterwards. The following summer, litter-fall was less than half that of the pre-burn summer. Standing stocks of BOM were significantly higher in autumn than in winter in the pre-burn year and were inversely related to discharge. Despite the heavy post-burn leaf-fall and low litter-fall during the post-burn summer, there was no significant difference between pre-burn and post-burn BOM standing stocks. Proportions and quantities of fine benthic organic matter in the soft BOM fraction were significantly higher in the post-burn spring, and monthly accumulation of ultra-fine benthic organic matter was also significantly higher in the post-burn spring and summer. These results may reflect accelerated decay rates of BOM in response to enhanced post-burn nitrate concentrations in stream water. Export of coarse particulate organic matter was low in comparison to fine particulate organic matter and particularly to ultra-fine particulate organic matter, and the stream appears to by highly retentive of coarse particulate organic matter. The natural resilience of the riparian vegetation minimizes the potentially disturbing effects of fire on the stream environment. As a result, the prescribed burn had a less than expected effect on both standing stocks of BOM and the stream environment in general. (Author's abstract)
W91-03826

TRACE METAL CHEMISTRY OF A DUTCH RESERVOIR, THE TJEUKEMEER.
Limnologisch Inst., Oosterzee (Netherlands). Tjeukemeer Lab.
H. De Haan, J. Voerman, T. De Boer, J. R. Moed, and J. Schrotenboer.
Freshwater Biology FWBLAB, Vol. 42, No. 2, p 391-400, October 1990. 4 fig, 2 tab, 14 ref.

Descriptors: *Heavy metals, *Reservoirs, *The Netherlands, *Trace metals, *Water pollution sources, Aluminum, Climates, Cobalt, Copper, Iron, Manganese, Path of pollutants, Peat, Wind-driven currents, Zinc.

The concentrations of total and dissolved (<0.2 micron) Fe, Mn, Cu, Co, Zn, and Al in the Dutch reservoir, the Tjeukemeer, were recorded fortnightly between 1984 and 1986. Due to its reservoir function, in winter the Tjeukemeer receives water that is relatively rich in Fe and Mn from its peaty drainage area. In summer, water from Lake IJsselmeer that is relatively rich in Cu and Zn is flushed by a tributary of the River Rhine into the lake. Therefore trace metal loads, as estimated from annual mean concentrations and hydraulic data, are climate-dependent. In wet years the annual Fe, Mn, Cu and Zn loads may be 3.1, 0.2, 0.001, and 0.009 g/sq m, respectively. In dry years, the Fe and Mn loads may be less than one quarter while the Cu and Zn loads may double. Comparable Cu and Zn inputs occur by deposition, particularly in wet years. Despite the dependence of trace metal loads on the climate-dependent water regime, Principal Component Analysis indicated no strong relation between the total Cu, Co, Zn and Al concentrations in lake water and hydrological tracers such as Cl(-) and UV absorbance. Instead, wind speed appeared to be more strongly connected with the dynamics of these metals. Thus in the shallow Tjeukemeer, internal trace metal loading due to wind-induced resuspension starts to dominate the contributions of external loads to the total metal concentrations at wind speeds exceeding 3 m/s. (Author's abstract)
W91-03827

FACTORS AFFECTING SULFUR INCORPORATION INTO LAKE SEDIMENTS: PALEOECOLOGICAL IMPLICATIONS.
State Univ. of New York at Syracuse. Coll. of Environmental Science and Forestry.
M. J. Mitchell, J. S. Owen, and S. Schindler.
Journal of Paleolimnology JOUPE8, Vol. 4, No. 1, p 1-22, 1990. 8 fig, 6 tab, 66 ref. Electric Power Research Institute RP-2174-10.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Lake sediments, *Limnology, *Paleolimnology, *Sulfur, Carbon, Hydrogen, Lake acidification, Nitrogen, Organic matter, Path of pollutants, Sulfates.

The use of sulfur as a paleolimnological tracer of limnetic sulfate concentration was examined as part of the Paleoecological Investigation of Recent Lake Acidification (PIRLA) program. A positive relationship was found between limnetic sulfate and sediment S concentrations for the Great Lakes, English Lakes, and lakes from the Adirondack and Northern New England regions. There is a positive correlation between carbon and sulfur concentration in sediment across all regions studied. For assessing historical changes in S accumulation in sediments, enrichment factors were calculated for the PIRLA lakes. Pre-1900 net sediment accumulation rates of S were vary similar across all regions. Sulfur enrichment was greatest in Adirondack sediment which had total post-1900 S accumulation of 1.1 to 7.4 times pre-1900 S accumulation. Sediment from Northern New England (NNE) generally had lower S concentration than Adirondack sediments and S enrichment factors ranged from 1.2 to 2.1. Sediment from the Northern Great Lakes States region had similar S concentration and distribution with depth to NNE sediment. In two Northern Florida lakes, sediment showed little variation in S concentration with depth, but in two other lakes from the same region, there was higher S concentration in deeper layers. Lakes which had the greatest enrichment factors also exhibited the most marked changes in C:S ratios. Ratios of C:N showed little variation (10.6 to 26.1) among the PIRLA lakes. A first order model indicated slow decomposition within these organic rich sediments. Elemental concentrations and ratios of sediment from a variety of lakes and reservoirs were compiled. Maximum and minimum elemental ratios for all data were 28 to 8.1 for C:N, 0.81 to 0.11 for C:H, and 675 to 12.5 for C:S. For the C:S ratios in all regions except the Great Lakes, the maximum ratio was less than 231. Both the maximum and minimum amount of N and H concentration of organic matter is related to biotic processes. The minimum concentration of S is regulated not only by nutrient demands but also by non-assimilatory processes. Sulfur incorporation into sediments is a function of a complex of factors, but limnetic sulfate concentration and organic matter content play a major role in regulating the S content of sediment. (Author's abstract)
W91-03828

STABLE ISOTOPIC COMPOSITIONS OF SULFUR IN PIRLA SEDIMENT CORES.
Marine Biological Lab., Woods Hole, MA. Ecosystems Center.
B. Fry.
Journal of Paleolimnology JOUPE8, Vol. 4, No. 1, p 23-29, 1990. 5 fig, 27 ref. NSF grant BSR-86-15191 and Electric Power Research Institute RP-2174-10.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Cores, *Isotopes, *Lake acidification, *Paleolimnology, *Sulfur, Isotopic composition, Lakes, Lead, Path of pollutants, Sediments, Sulfur deposition.

Patterns of sulfur isotope change in cores taken in the Paleoecological Investigation of Recent Lake Acidification (PIRLA) project were identified, and the isotopic stratigraphy was used to establish histories of sulfur loading. Stable isotopic compositions of total sedimentary sulfur were determined for cores from eight PIRLA study lakes. Preindustrial sulfur deposited prior to 1800 had roughly constant isotopic compositions within a 1-2‰ range in each core. In more recent sediments, large 5-10‰ decreases in 34S content occurred and likely resulted from the addition of anthropogenic sulfur. These isotopic changes began at the same time that lead concentrations increased in sediments, suggesting a close linkage between lead and sulfur deposition in the mid and late 1800s. (Author's abstract)

W91-03829

PALAEOECOLOGICAL TEST OF THE LAND-USE HYPOTHESIS FOR RECENT LAKE ACIDIFICATION IN SOUTH-WEST NORWAY USING HILL-TOP LAKES.
Bergen Univ. (Norway). Botanical Inst.
H. J. B. Birks, F. Berge, J. F. Boyle, and B. F. Cumming.
Journal of Paleolimnology JOUPE8, Vol. 4, No. 1, p 69-85, 1990. 4 fig, 3 tab, 60 ref.

Descriptors: *Acid rain, *Acid rain effects, *Cores, *Lake acidification, *Lakes, *Land use, *Limnology, *Norway, *Paleolimnology, Chrysophytes, Diatoms, Geochemistry, Hill-top lakes, Hydrogen ion concentration, Pollen.

Recent acidification of Scandinavian lakes and associated biotic changes, such as dramatic decreases in fish populations, are now well documented. Three hypotheses have been proposed to explain these changes: (1) recent increases in the acidity of precipitation resulting from emission of S and N compounds; (2) decreasing pastoral activities in upland areas which have resulted in changes in humus accumulation and decomposition, and acidification of drainage water; and (3) natural long-term acidification of soils as a result of retrogressive soil development during the later phases of all interglacial stages. Lakes perched on hill-tops are ideal sites for testing the hypothesis that land-use associated soil changes are a major cause of recent lake acidification because they have very small catchments, and their water chemistry is largely influenced by the chemical composition of precipitation and underlying bedrock geology. Hill-top lakes in SW Norway were used to test the hypothesis that land-use contributes to lake acidification because their chemistry is little affected by land-use or soil changes. Cores were taken from the deepest point in Holetjorn and Ljosvatn lakes in the Noi-Flekkefjord-Kvinesdal area of Vest-Agdar. Paleolimnological analyses of diatoms and chrysophytes show that prior to ca. 1914 the two hill-top lakes investigated were naturally acid with reconstructed lake pH values of at least 4.8-5.1. Since ca. 1914 lake pH values declined to ca. 4.5-4.7. These results contradict the land-use hypothesis. All the available paleolimnological evidence (diatoms, chrysophytes, pollen, sediment geochemistry, carbonaceous particles) is consistent with the acid-deposition hypothesis. (White-Reimer-PTT)
W91-03830

DEVELOPMENT OF AN INTERDISCIPLINARY PLANNING MODEL FOR WATER AND FISHERY MANAGEMENT.
New Mexico State Univ., Las Cruces. Dept. of Fishery and Wildlife Sciences.
For primary bibliographic entry see Field 6A.
W91-03855

FATE OF NITROGEN AND PHOSPHORUS ENTERING A GULF COAST FRESHWATER LAKE: A CASE STUDY.
Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.
For primary bibliographic entry see Field 5B.
W91-03857

UNDERWATER PHOTIC ENVIRONMENT OF A SMALL ARCTIC LAKE.
Montreal Univ. (Quebec). Dept. of Biological Sciences.
P. H. Heinermann, L. Johnson, and M. A. Ali.
Arctic ATICAB, Vol. 43, No. 2, p 129-136, June 1990. 8 tab, 1 fig, 63 ref.

Descriptors: *Arctic zone, *Lakes, *Light penetration, *Limnology, *Victoria Island, Canada, Diurnal variation, Keyhole Lake, Model studies, Photoperiodism, Radiation, Simulation analysis, Transmissivity.

The underwater light field in a small arctic lake on Victoria Island, Northwest Territories, was examined. Downward radiance was found to be bimodal, with transmission peaks at 480 and 640 nm. Upward radiance was similar near the surface with peaks at 480 and 620 nm, but became unimodal with depth and shifted to 580 nm near the bottom. Diurnal variation in the underwater downward and upward irradiance of PAR (photosynthetically active radiation), was approximately two orders of magnitude. The spectral quality of light transmission also changed over this 24 hour period. Unimodal transmission of red light occurred in the early morning (1:00 and 5:00) and late evening (22:00), while bimodal transmission of blue-green and red light was observed during the day (9:00-17:30). The vertical attenuation coefficient for downward irradiance at the midpoint of the euphotic zone, was relatively insensitive to changes in solar elevation. Diurnal variation in the reflectance of PAR differed from that predicted by previous simulation model while the inverse relationship between reflectance and the absorption coefficient was in agreement with these same models. Gilvin, humic material in dissolved iron complexes, algal fucoxanthin, chlorophyll a and tripton all contribute to the attenuation of light, and are responsible for the unique underwater spectral transmission in Keyhole Lake. (Author's abstract)
W91-03864

EFFECTS OF BEAVER DAMS ON SUBARCTIC WETLAND HYDROLOGY.
McMaster Univ., Hamilton (Ontario). Dept. of Geography.
M. K. Woo, and J. M. Waddington.
Arctic ATICAB, Vol. 43, No. 3, p 223-230, September 1990. 9 fig, 4 tab, 18 ref.

Descriptors: *Beaver ponds, *Environmental effects, *Subarctic zone, *Wetlands, Flood peak, Flooding, Hydrologic properties, Low flow, Runoff, Streamflow.

Beaver dams are ubiquitous in subarctic wetlands, where runoff in a flat terrain is highly prone to changes as the stream courses are modified by beaver activities. Depending on the state of preservation, streamflow can overtop or funnel through gaps in the dams, leak from the bottom of the dams, or seep through the entire structure. Peak and low flows are regulated by these dams to a varying extent. The formation of beaver ponds causes local flooding, while the open water surfaces of the ponds increase water loss from the wetlands. Water spilled from the dams may cause diversion channels to produce complex drainage patterns. Comparing the water balance of basins with and without a beaver dam at its outlet confirms that the dammed basin lost more water to evaporation, suppressed the outflow, and increased the basin water storage. (Author's abstract)
W91-03867

CONSERVATION OF ENDEMIC RAIN FOREST FISHES OF SRI LANKA: RESULTS OF A TRANSLOCATION EXPERIMENT.
California Univ., Davis. Dept. of Wildlife and Fisheries Biology.
For primary bibliographic entry see Field 8I.
W91-03869

BIODIVERSITY LOSS IN THE TEMPERATE ZONE: DECLINE OF THE NATIVE FISH FAUNA OF CALIFORNIA.
California Univ., Davis. Dept. of Wildlife and Fisheries Biology.
For primary bibliographic entry see Field 6G.
W91-03870

2I. Water In Plants

MODELLING OF ENERGY FORESTRY: GROWTH, WATER RELATIONS AND ECONOMICS.
Simulation Monographs 30. Centre for Agricultural Publishing and Documentation (Pudoc), Wageningen, The Netherlands, 1989. 199p. Edited by K. L. Perttu and P. J. Kowalik.

Descriptors: *Computer programs, *Energy sources, *Forestry, *Model studies, *Simulation analysis, *Soil-water-plant relationships, Economic aspects, Evaporation, Plant growth, Sweden, Transpiration, Willow trees.

This comprehensive volume, which is divided into four parts, documents the modeling of production, water relations and the economics of intensively cultivated short rotation energy forests. The first part gives the background to energy forestry in general, and discusses simulation models. The second part examines growth processes in willow stands, biomass growth processes, and assimilate allocation and nitrogen turnover. The model presented in this part describes willow growth simulation with annual results from a three year cutting cycle. In the third part, three different models are presented on water relations in willow, which is one of the main species for Swedish energy forestry. The fourth part comprises an economic calculation for energy forestry on agricultural land in Sweden as well as the prospects for wood biomass as a regenerable, alternative energy resource. The appendix describes the simulation packages, and contains a sample model for understanding the modeling efforts. (See W91-03199 thru W91-03202) (Author's abstract)
W91-03198

INTRODUCTION TO MODELLING OF PLANT WATER CONDITIONS.
Gdansk Technical Univ. (Poland). Inst. of Hyrdotechnics.
P. J. Kowalik, and K. L. Perttu.
IN: Modelling of Energy Forestry: Growth, Water Relations and Economics. Simulation Monographs 30. Centre for Agricultural Publishing and Documentation (Pudoc), Wageningen, The Netherlands. p 89-96, 1 tab, 32 ref.

Descriptors: *Evaporation, *Forestry, *Model studies, *Plant growth, *Soil-water-plant relationships, *Transpiration, Air temperature, Biomass, Canopy, Comparison studies, Energy, Interception, Irrigation effects, Plant water potential, Radiation, Rainfall, Relative humidity, Soil water, Willow trees.

Three models of soil-water-plant relationships can be used complementarily to determine the variables needed to yield good biomass when dealing with plant growth and water balance in energy forests. In the Kowalik and Eckersten transpiration model, the driving variables consist of recorded 10-minute mean values, diurnal totals and diurnal single values for air temperature, relative air humidity, solar radiation, soil water potential and precipitation. The model describes the diurnal course of transpiration, stomatal behavior, leaf water potential and leaf canopy temperature. The results indicate the importance of the evaporation of intercepted water for heat and mass exchange in the energy forest ecosystems; both amount and duration of rainfall seem to be important factors. In the Halldin evaporation model, the Penman approach is used to simulate willow evaporation. The concept central to Halldin's model is to calculate evaporation, divided into transpiration and evaporation of intercepted water, and to create a simple one-layer soil water budget. The soil water is described in terms of a single compartment and thus the vertical distribution of water uptake in the soil is ignored. The soil water balance is defined as the total available soil water at field capacity minus that at the wilting point. This total is then divided into the fraction of easily available water that does not limit transpiration, and the fraction for which transpiration decreases linearly from its potential value to zero. The Persson and Jansson model is a continuation of the development of earlier Swedish attempts to model soil water and predicts water dynamics for a variety of soils and vegetation covers. The rate of water uptake by roots from different depths depends on plant water requirements, availability of water, and ability of the roots to take up water. The model also evaluates the effects of irrigation. (See also W91-03198) (Geiger-PTT)
W91-03199

SIMULATION OF DIURNAL TRANSPIRATION FROM WILLOW STANDS.
Gdansk Technical Univ. (Poland). Inst. of Hyrdotechnics.
P. Kowalik, and H. Eckersten.
IN: Modelling of Energy Forestry: Growth, Water Relations and Economics. Simulation Monographs 30. Centre for Agricultural Publishing and Documentation (Pudoc), Wageningen, The Netherlands. p 97-119, 6 fig, 36 ref.

Descriptors: *Computer programs, *Diurnal variation, *Forestry, *Mathematical models, *Model studies, *Soil-water-plant relationships, *Transpiration, *Willow trees, Air temperature, Evaporation, Fortran, Interception, Radiation, Relative humidity, Soil water potential.

A computer model of the soil-plant-atmosphere system was applied to simulate transpiration and evaporation of intercepted water and leaf temperature within time steps of one minute in stands of willow in energy forests. Data to test the transpiration model were collected over a two year period at Studsvik, Sweden. Good agreement between estimated and measured leaf-air temperature differences and cumulative transpiration was obtained during periods when the assumptions in the model were fulfilled. The assumptions of a constant aerodynamic resistance or soil hydraulic resistance were not satisfactory and the model should be improved on these points. The results show the importance of evaporation of intercepted water for heat and mass exchange in the energy forest. Rainfall amount and duration are both important factors that must be known. The source code of this SPAC model is written in FORTRAN 77 and makes use of the SIMP simulation modelling support programs. (See also W91-03198) (Geiger-PTT)
W91-03200

WILLOW STAND EVAPORATION: SIMULATION OF DIURNAL DISTRIBUTION USING SYNOPTIC WEATHER DATA.
Uppsala Univ. (Sweden). Dept. of Hydrology.
S. Halldin.
IN: Modelling of Energy Forestry: Growth, Water Relations and Economics. Simulation Monographs 30. Centre for Agricultural Publishing and Documentation (Pudoc), Wageningen, The Netherlands. p 121-146, 9 fig, 27 ref.

Descriptors: *Computer models, *Diurnal distribution, *Evaporation, *Forestry, *Hydrologic budget, *Irrigation requirements, *Model studies, *Willow trees, Fortran, Interception, Transpiration, Weather data collections.

Simple models of the water balance of willow stands are useful to assess irrigation needs in energy forests. Such models rely on evaporation data that can fluctuate diurnally. To overcome this conflict, the KAUSHA model was used dividing the 24-hr cycle into a night-time part and a daytime part. The model was evaluated in a mature Scots pine forest at Jaedraas, central Sweden. Porometer measurements of stomatal resistance allowed independent estimation of parameter values in the Lohammar equation, and these values were used together with climatic data for the whole of 1977 to compare results of the various diurnal distributions for situations without precipitation. Three pulses were tested. One pulse was the astronomically determined day length as duration and a second pulse was 75% as long. A comparison was also made with a 24-hr pulse, to see whether a model without any diurnal distribution might be as good as the other two. All the pulses gave reasonably coherent results, but the 24-hr pulse deviated considerably from a one-to-one relation with the sinusoidal distribution. The pulse of day-time duration was close to linearly related to the sinusoidal distribution, but its value was 10% higher. The pulse using an effective day length of 75% could hardly be distinguished from the sinusoidal distribution in terms of resulting evaporation. (See also W91-03198) (Geiger-PTT)
W91-03201

SIMULATED WATER BALANCE OF A WILLOW STAND ON CLAY SOIL.
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences.
G. Persson, and P. E. Jansson.
IN: Modelling of Energy Forestry: Growth, Water Relations and Economics. Simulation Monographs 30. Centre for Agricultural Publishing and Documentation (Pudoc), Wageningen, The Netherlands. p 147-162, 8 fig, 2 tab, 17 ref.

Descriptors: *Clays, *Computer models, *Forestry, *Hydrologic budget, *Model studies, *Soil water, *Soil-water-plant relationships, *Willow trees, Evapotranspiration, Percolation, Soil properties.

Water balance was estimated in a clay soil using a physically based soil water model (SOIL) in willow stands in Ultuna, Sweden. The model is based on a soil moisture study recorded from thirty-two tensiometers installed in four lines at 15, 30, 45 and 60 cm depth. Daily totals of precipitation, irrigation, global radiation and averages of air temperature, vapor pressure and wind speed were used as driving variables for the model. Water retention curves for a 1 m deep soil profile were obtained from a field about 50 m from the study site. The model also incorporated the effects of stand properties such as interception storage and surface resistance. When different combinations of soil and plant properties were used in the model, good agreement was obtained between simulated and measured tensions. The uncertainty of most importance for the simulated evapotranspiration was the occurrence and efficiency of deep roots, especially if the deep roots were combined with a poor drainage efficiency. (See also W91-03198) (Geiger-PTT)
W91-03202

VEGETATION DYNAMICS IN RELATION TO WETLAND CREATION.
Connecticut Coll., New London.
W. A. Niering.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 479-486, 1 fig, 67 ref.

Descriptors: *Artificial wetlands, *Planting management, *Soil-water-plant relationships, *Vegetation establishment, *Water resources management, *Wetland restoration, *Wetlands, Ecosystems, Hydrologic cycle, Hydrological regime, Plant populations, Succession, Water resources development, Wildlife habitats.

An understanding of the ecological processes involved in coastal or freshwater wetland vegetation development is essential to wetland managers concerned with wetland creation. Ascertaining a sound hydrologic system is basic in any attempt to recreate a wetland system since the vegetation and associated fauna are dependent upon a consistent but usually fluctuating hydrologic regime. Any hydrologic manipulations can also greatly modify what species will become established in a given site or those that may decline in abundance. Traditional succession-climax dogma has limited usefulness in interpreting vegetation change. Thus an understanding of the complex of factors involved in the process, including chance and coincidence, makes the task of the manager even more challenging. Since vegetation change is not necessarily predictable and orderly, as is sometimes thought, it is often difficult to predict the ultimate vegetation in a given created site. Some wetland communities once created may be relatively stable; others may undergo directional or cyclic change, thus adding to the complexity of the ultimate vegetation. Therefore, one of the major goals in wetland creation should be the persistence of the wetland as a self-perpetuating oscillating system. This can be achieved by assuring a sound hydrologic regime. (See also W91-03244) (Author's abstract)
W91-03266

ROOT AERENCHYMA, OXYGEN LEAKAGE PATTERNS AND ALCOHOLIC FERMENTATION ABILITY OF THE ROOTS OF SOME NYMPHAEID AND ISOETID MACROPHYTES IN RELATION TO THE SEDIMENT TYPE OF THEIR HABITAT.
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
A. J. M. Smits, P. Laan, R. H. Thier, and G. van der Velde.
Aquatic Botany AQBODS, Vol. 38, No. 1, p 3-17, October 1990. 3 fig, 2 tab, 60 ref.

Descriptors: *Aquatic plants, *Limnology, *Macrophytes, *Plant morphology, *Rooted aquatic plants, *Sediments, *Soil-water-plant relationships, Alcohols, Anoxic conditions, Aquatic habitats, Fermentation, Oxidation-reduction potential, Oxygen requirements, Root development, Roots.

Apart from other numerous environmental factors affecting the growth of aquatic plants, the organic matter content of the sediment greatly influences the distribution of aquatic macrophytes. Morphological and metabolic characteristics of the roots of two groups of aquatic macrophytes are compared. The first group consists of species frequently occurring on organic sediments with a distinct negative redox potential, such as the nymphaeid macrophytes. The second group contains species generally rooting in a mineral sediment with an oxidative character, such as the isoetids. As a measure for the amount of root aerenchyma, root porosity of these macrophytes was determined. The nymphaeids which were grown in the same type of sediments as the isoetids developed a larger amount of root aerenchyma. Moreover, the roots of the nymphaeids differed from the roots of the isoetids by a reduced oxygen permeability of the root wall and a higher ethanol fermentation rate during anoxic conditions. If the gas permeability of the root wall is high, a large part of the oxygen present in the root will diffuse into the sediment and will subsequently be reduced. Morphological characteristics (i.e., well-developed root aerenchyma and reduced oxygen permeability of the roots), as well as an extensive alcoholic fermentation ability of the roots of the nymphaeids, can be considered essential adaptations to the strong reductive sediments of their habitats. In addition, the lack of these characteristics in the isoetid roots can partly explain why the occurrence of these macrophytes is confined to water bodies with a mineral sediment characterized by a small reductive capability. (Fish-PTT)
W91-03414

ADAPTATIONS TO FLOODING IN PLANTS FROM RIVER AREAS.
Katholieke Univ. Nijmegen (Netherlands). Dept. of Experimental Botany.
C. W. P. M. Blom, G. M. Bogemann, P. Laan, A. J. M. van der Sman, and H. M. van de Steeg.
Aquatic Botany AQBODS, Vol. 38, No. 1, p 29-47, October 1990. 5 fig, 7 tab, 47 ref.

Descriptors: *Adaptation, *Aquatic plants, *Flood plains, *Species composition, *The Netherlands, *Waterlogging, Bioindicators, Flood frequency, Flooding, Flowering, Leaves, Netherlands, Oxygen requirements, Rhine River, River systems, Roots, Soil-water-plant relationships, Submergence, Vegetation, Water level fluctuations.

Flood frequencies and intensities determine both species composition and the behavior of individual plants along many rivers in the world. The vegetation zonation associated with the fluctuating water levels of the Rhine River in the eastern part of The Netherlands was studied. Certain species were chosen as being representative of the vegetation types from the river foreland, and were subjected to various flooding regimes in order to study the adaptive responses upon waterlogging of the soil, submergence, and related changing environmental factors. Differential responses towards flooding in plants can be explained, at least partly, by an ability to elongate petioles and stems in order to protrude above the water surface. The hormone ethylene is involved in the regulation of this process. Renewed contact between leaves and the open air after submergence stimulates the formation of a new aerenchymatous root system in the flood-tolerant species. Increased porosity enables the plants to perform longitudinal transport from aerial and photosynthetic oxygen to the rhizosphere. The internal aeration system of flood-intolerant species

is not sufficient to sustain an aerobic state in the root-soil environment. Another mechanism plants use to survive flooding is to change their timing of reproduction: some species delay their flowering and seed production during flooding periods and survive as vegetative plants; others are able to accelerate flowering during short dry periods in order to produce seeds in the short intervals between two successive floods. The model system in which individual plants serve as indicator species appears to be a manageable tool in studies on adaptations to flooding. (Author's abstract)
W91-03415

ECOPHYSIOLOGY OF PLANTS IN WATERLOGGED AND FLOODED ENVIRONMENTS.
Vrije Univ., Amsterdam (Netherlands). Dept. of Ecology and Ecotoxicology.
W. H. O. Ernst.
Aquatic Botany AQBODS, Vol. 38, No. 1, p 73-90, October 1990. 1 fig, 122 ref.

Descriptors: *Adaptation, *Aquatic plants, *Ecosystems, *Flood plains, *Soil-water-plant relationships, *Waterlogging, Anoxic conditions, Carbon, Iron, Manganese, Metabolism, Nitrogen, Oxygen requirements, Photosynthesis, Resistance, Roots, Sulfur, Vegetation.

Waterlogging and/or flooding of ecosystems may be permanent, as in marshes and bogs, or may occur in a regular daily or seasonal pattern, e.g., the daily flooding of the lower salt marsh or seasonally flooded dune slacks and wetlands. The adaptation of higher plants to waterlogged and flooded environments was studied. The primary effect in the sequence of waterlogging-induced processes is a reduction of the oxygen concentration of the soil. The longer the period of waterlogging lasts, the more the speciation of nitrogen, manganese, iron, sulfur, and carbon changes from the oxidized to the reduced state, often counteracted by a well-functioning aerenchyma. The change in the speciation of soil nitrogen has no effect on plants resistant to waterlogging, whereas reduction of sulfur demands specific adaptations. Secondary metabolic changes as reactions to waterlogging will involve glycolysis, but depend on the extent of anoxia in the soil and thus the root. Flooding will enhance the sequence of waterlogging-induced processes. As soon as the green plant parts are flooded and excluded (partially) from the ambient air, a reduction in photosynthesis will take place and severely affect the energy budget. in addition to ecophysiological adaptation, waterlogging-resistant species may play a role in the survival of less resistant species in the same plant community. (Author's abstract)
W91-03416

GENETIC VARIATION AND ADAPTATION TO FLOODING IN PLANTS.
University of East Anglia, Norwich (England). School of Biological Sciences.
A. J. Davy, S. M. Noble, and R. P. Oliver.
Aquatic Botany AQBODS, Vol. 38, No. 1, p 91-108, October 1990. 1 fig, 2 tab, 58 ref.

Descriptors: *Adaptation, *Aquatic plants, *Flood plains, *Flooding, *Genetics, *Limnology, *Riverine limnology, *Soil-water-plant relationships, DNA, Molecular structure, Plant populations, Salt marshes, Species composition, Tolerance, Variation, Waterlogging.

Evidence exists for genetic variation that can be associated with the evolution of adaptations to flooding: variation related to flooding at the level of molecular mechanism; comparisons of the patterns of variation in flooding-tolerant and non-tolerant species; within-species variation associated with genetically-differentiated populations that enable certain higher plants to tolerate or avoid the effects of flooding are understood. Yet little is known of the genetic basis for these features and less of its variation. An analysis was done of Salicornia, which exists as locally differentiated populations in different tidal flooding regimes, from the lowest to the highest parts of salt marshes. Genetic differentiation can be demonstrated by significant selection coefficients against alien types in reciprocal transplant experiments. The genetic variation within and between these populations were investigated using restriction fragment length polymorphism studies of the ribosomal DNA (rDNA). Two rDNA repeat unit types were found, only one of which occurs in any individual plant. Only the 12-kilobase (kb) fragment was found in populations that experience the most flooding, whereas plants on the highest parts of the marsh had only the 10.5-kb fragment. Typical lower and upper marsh populations were mixed in their fragment compositions, but lower marsh areas supported a higher frequency of the 12-kb fragment than upper marsh and depressions supported a higher frequency of the 12-kb fragment than raised interfluve areas. The use of such DNA variation, which is itself unselected, as a marker for selected genetic variation shows considerable promise for the future. (Author's abstract)
W91-03417

INTERACTIVE EFFECTS OF SALINITY AND CALCIUM ON HYDRAULIC CONDUCTIVITY, OSMOTIC ADJUSTMENT, AND GROWTH IN PRIMARY ROOTS OF MAIZE SEEDLINGS.
Technion - Israel Inst. of Tech., Haifa. Faculty of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W91-03520

CROPPING STRATEGIES FOR EFFICIENT USE OF WATER AND NITROGEN.
For primary bibliographic entry see Field 3F.
W91-03633

ROLE OF CROP RESIDUE MANAGEMENT IN NITROGEN CYCLING USE.
Agricultural Research Service, Lincoln, NE.
For primary bibliographic entry see Field 3F.
W91-03639

ROLE OF NONLEGUMINOUS COVER CROPS IN THE EFFICIENT USE OF WATER AND NITROGEN.
North Carolina State Univ., Raleigh.
For primary bibliographic entry see Field 3F.
W91-03640

ROLE OF ANNUAL LEGUME COVER CROPS IN EFFICIENT USE OF WATER AND NITROGEN.
Kentucky Univ., Lexington.
For primary bibliographic entry see Field 3F.
W91-03641

ROLE OF CROPPING SYSTEMS IN ENVIRONMENTAL QUALITY: SALINE SEEP CONTROL.
Agricultural Research Service, Akron, CO.
For primary bibliographic entry see Field 3F.
W91-03644

EXAMINING EVAPOTRANSPIRATION IN A SEMI-ARID REGION USING STABLE ISOTOPES OF HYDROGEN AND OXYGEN.
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2D.
W91-03740

WATER BALANCE OF SNOW TUSSOCK GRASSLAND IN NEW ZEALAND.
Otago Univ., Dunedin (New Zealand). Dept. of Geography.
For primary bibliographic entry see Field 2D.
W91-03750

INTERCEPTION, THROUGHFALL AND STEMFLOW IN A FOREST IN HIGHLAND SCOTLAND AND THE COMPARISON WITH OTHER UPLAND FORESTS IN THE U.K.
Institute of Hydrology, Balquhidder, Lochearnhead FK19 8PQ, Scotland.
R. C. Johnson.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 281-287, October 1990. 4 fig, 2 tab, 9 ref.

Descriptors: *Forest hydrology, *Interception, *Scotland, *Stemflow, *Throughfall, Annual precipitation, Canopy, Coniferous forests, Interception loss, Seasonal variation, Snow storage, Spatial distribution, Spruce trees, Trees.

Interception loss from a 50-year-old Sitka spruce forest at Balquhidder in Highland Scotland has been determined by measuring precipitation, throughfall and stemflow. Annual mean precipitation at the site was 2130 mm and for the period October 1983 to June 1986, the average interception was 28% with throughfall and stemflow comprising 69 and 3%, respectively of the precipitation. This interception loss is similar to results from other upland forests in the U.K. While large variations were found throughout the year, interception was greatest in the summer months, reaching 79% in May 1985, and least in the winter, 0% in January 1985. Snow interception can be large, 37% in January 1984 when storage on the canopy was estimated to have reached 22 mm water equivalent. The spatial variability of throughfall was dependent on distance away from the tree stem and on the density of the canopy cover. Tree age does not appear to determine interception values but comparison of the relative amounts of throughfall and stemflow with those from other sites shows that there is an increase in throughfall with the age of the tree. This has important consequences for water quality in young forests. (Author's abstract)
W91-03753

2J. Erosion and Sedimentation

SEDIMENT-TRANSPORT CHARACTERISTICS AND EFFECTS OF SEDIMENT TRANSPORT ON BENTHIC INVERTEBRATES IN THE FOUNTAIN CREEK DRAINAGE BASIN UPSTREAM FROM WIDEFIELD, SOUTHEASTERN COLORADO, 1985-88.
Geological Survey, Denver, CO. Water Resources Div.
P. von Guerard.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4161, 1989. 133p, 20 fig, 19 tab, 39 ref. Project no. C0196.

Descriptors: *Benthic fauna, *Sediment transport, Bed load, Bed material, Sediment discharge, Suspended sediments.

Sediment and benthic-invertebrate data were collected during water years 1985 through 1988 in the Fountain Creek drainage basin upstream from Widefield, Colorado. Sediment data collected include suspended-sediment concentrations and particle size analysis of suspended sediment, bedload, and bed material. Sediment-transport equations were derived for total suspended-sediment discharge and suspended-sand discharge at seven periodic sampling sites. Annual suspended-sediment loads for water years 1985 through 1988 and mean suspended-sediment yields were computed for the seven periodic sampling sites. Mean annual suspended-sediment yield for 1985 through 1988 increased about 73% downstream in the Fountain Creek drainage basin primarily as a result of sediment discharging from Monument Creek. Bedload discharge was computed at six of the periodic sampling sites and ranged from 2.6 to 3,570 tons/day. Bedload discharge, as a percentage of total sediment discharge, ranged from 6 to 92%, and the smaller values occurred during rainfall runoff. Number of taxa, species density, and similarity indices were determined for benthic invertebrates at five of the periodic sampling sites. Multiple comparison tests were used to test for similarity of benthic invertebrates between the five sites. Multiple-regression analysis was done to determine the effects of sediment transport on benthic-invertebrate densities. Median grain size of bed material collected in conjunction with benthic-invertebrate samples and flooding during the 30 days prior to

sampling consistently accounted for the most variation in mean densities of total organisms and major taxa groups sampled. (USGS)
W91-02963

SAN FRANCISCO CENTRAL BAY SUSPENDED SEDIMENT MOVEMENT. REPORT 1: SUMMER CONDITION DATA COLLECTION PROGRAM AND NUMERICAL MODEL VERIFICATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
L. M. Hauck, A. M. Teeter, W. Pankow, and R. A. Evans.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report No. HL-90-6. September 1990. Report 1 of a Series. 122 p, 23 fig, 8 tab, 21 plates, 68 ref.

Descriptors: *Data acquisition, *Model studies, *San Francisco Bay, *Sediment transport, *Suspended sediments, Currents, Field tests, Mathematical models, Salinity, Water quality.

Field data were collected on currents, salinities, and suspended sediments intensively over a lunar day, and sporadically over a fortnight, in September 1988 for the purpose of identifying transport processes and conditions in central San Francisco Bay, and for numerical model verification. The field data collected during the low freshwater inflow period of September 1988 indicated that Central Bay had near-oceanic salinities, was vertically well mixed, and had moderately low total suspended material (TSM). Net delta outflow of fresh water into the bay system was only about 2,500 cu ft/sec (cfs) during this period. TSM at the Golden Gate survey range averaged about 16 mg/L, increased upstream to 34 mg/L at the entrance to South Bay, and increased to 45 mg/L at the Richmond Bridge near the entrance to San Pablo Bay. Peak TSM values were greater than average values by a factor of about three. Tidal fluxes of TSM were large, commensurate with the tidal prism of this system. Observed tidal fluxes were roughly 30,000 metric tons per lunar day at the Golden Gate range, 19,000 metric tons per lunar day at the entrance to the South Bay, and 44,000 metric tons per lunar day at Richmond. Conditions were typical of a low freshwater inflow summer season in this area. A two-dimensional horizontal finite element was applied and verified to field and physical hydraulic model data. (Lantz-PTT)
W91-03010

LOUISIANA SCOUR ANALYSIS MANAGEMENT SYSTEM (LASAMS).
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W91-03076

SOIL EROSION AND CONSERVATION.
This volume is based on 'Malama Aina '83,' the International Conference on Soil Erosion and Conservation, held January 16-22, 1983, in Honolulu, Hawaii. Soil Conservation Society of America, Ankeny, Iowa. 1985. 793p. Edited by S. A. El-Swaify, W. C. Moldenhauer, and Andrew Lo.

Descriptors: *Conferences, *Erosion control, *Model studies, *Sediment sources, *Soil conservation, *Soil erosion, Crop yield, Hawaii, Management planning, Mathematical models, Network design, Nonpoint pollution sources, Water pollution control, Water pollution sources.

Highly visible land degradation, widespread famine, and heightened environmental awareness have prompted worldwide interest in soil and water conservation. The International Conference on Soil Erosion and Conservation, held at Honolulu, Hawaii, in 1983, provided a continuing forum for the exchange of research findings and experiences in the search for solutions to soil and water conservation problems. This volume is based on papers presented at the meeting. Four themes were emphasized: (1) delineating sediment sources and estimating the magnitude and extent of soil erosion (methodological, analytical, and country reports); (2) quantifying the impacts of soil erosion and sedimentation on land productivity and the environment (changes in soil fertility and physical properties, experimental and modeling efforts to assess crop responses, soil water characteristics as an element of productivity, particularly for arid/semiarid regions, and economic assessment of erosion impact); (3) establishing quantitative values for erosion-causing parameters (parameter assessment, modeling and model adaptation, and manipulation for controlling erosion); and (4) creating global and regional networks for implementing soil and water conservation programs (unifying principles, needs, terminology, methodology, reporting, and interdisciplinary requirements for conservation-effective land use planning). (See W91-03118 thru W91-03177) (Rochester-PTT)
W91-03117

SOIL CONSERVATION IN INDIA.
Central Soil and Water Conservation Research and Training Inst., Dehra Dun (India).
For primary bibliographic entry see Field 4D.
W91-03118

OVERVIEW OF SOIL EROSION AND SEDIMENTATION IN THAILAND.
Kasetsart Univ., Bangkok (Thailand). Dept. of Soils.
S. Jantawat.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 10-14, 1 tab, 10 ref.

Descriptors: *Erosion rates, *Sediment erosion, *Sedimentation, *Soil erosion, *Thailand, Chi River, Deforestation, Huai Pa Tao River, Lame Dome Noi River, Mune-Chi River, Water pollution sources.

Soil erosion occurs extensively on rolling cropland in Thailand. Soil erosion can be measured directly at several sites. It also can be computed using an empirical formula for a given soil type, slope, and management, or it can be estimated from the rate of sediment transport in rivers. For regional analysis, suspended sediment measurements provide a convenient index of mean soil erosion rates. Soil erosion rates were estimated for 79 watersheds in Thailand (8.45 to 104,000 sq km). Sediment production rates ranged from 7.61 to 3873.79 t/sq km/yr. The highest erosion rate was in the Lame Dome Noi River watershed, which is a tributary of the Mune-Chi River. The lowest rate was in Huai Pa Tao River Basin, a tributary of the Chi River. Soil erosion in the five regions of Thailand ranged from 11.86 to 2044.98 t/sq km/yr in the northern region, 7.61 to 3873.79 t/sq km/yr in the northeast, 20.14 to 569.60 t/sq km/yr in the central plains region, 26.77 to 355.79 t/sq km/yr in the eastern region, and 30.23 to 1786.98 t/sq km/yr in the southern region. The highest erosion rates occurred in the northeastern region, where the largest area of deforestation has occurred, suggesting that soils in this region are sensitive to erosion when natural cover is removed. (See also W91-03117) (Rochester-PTT)
W91-03119

CONSEQUENCES OF HEAVY MECHANIZATION AND NEW ROTATION ON RUNOFF AND ON LOESSIAL DEGRADATION IN NORTHERN FRANCE.
Office de la Recherche Scientifique et Technique Outre-Mer, Paris (France).
For primary bibliographic entry see Field 4C.
W91-03121

EFFECTS OF GRAZING AND TRAMPLING ON SOIL DETERIORATION AROUND RECENTLY DRILLED WATER HOLES IN THE SAHELIAN ZONE.
Office de la Recherche Scientifique et Technique Outre-Mer, Abidjan (Ivory Coast).
For primary bibliographic entry see Field 4C.
W91-03122

EFFECTS OF VARIOUS VEGETATION LAYERS IN AN ACACIA AURICULIFORMIS FOREST PLANTATION ON SURFACE EROSION IN JAVA, INDONESIA.
Agricultural Univ., Wageningen (Netherlands). Dept. of Forest Management.
K. F. Wiersum.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 79-89, 1 fig, 3 tab, 16 ref.

Descriptors: *Acacia trees, *Forest watersheds, *Indonesia, *Soil erosion, *Vegetation effects, Ecosystems, Java, Litter, Soil conservation, Ubrug Forest.

Few data have been published on the interactions and relative importance of the different effects of various forest components on erosion. More than 40 yr ago, Coster published such a study for forests in Java, in which the effects of different forest components were studied by removing them and then measuring incident rainfall and sediment loss. In the present study, a more integrated approach was used that accounted for the separate effects of the various vegetation layers. The research site was in the Ubrug forest near Jatiluhur (W Java, Indonesia) on a clayey soil in an area of 2,900 mm average annual rainfall. Canopy effects on amount and erosive force of precipitation, undergrowth and litter effects on erosion, and the combined effect of the various vegetation layers were examined. The findings on the relative importance for erosion protection of the various vegetation layers support Coster's results. Erosion without direct soil cover (litter layer) is an order of magnitude higher. The addition of other vegetative layers does not change the erosion rate significantly. In fact, the presence of trees without litter may actually increase erosion. This study indicates that the protective influence of forest vegetation depends mostly on the vegetation's influence on the interface between the erosive agent and the eroded medium, rather than on its direct influence on these two properties. Trees have a variable, and often negative effect, in protecting the soils from rainfall, whereas the positive effect of humus incorporation on the soil develops over longer periods. It is the proper functioning of the forest ecosystem rather than the presence of trees that is important for erosion control. (See also W91-03117) (Rochester-PTT)
W91-03124

SOIL EROSION STUDIES IN THE NORTHERN MOUNTAIN RANGE, TRINIDAD, UNDER DIFFERENT CROP AND SOIL MANAGEMENT.
University of the West Indies, St. Augustine (Trinidad and Tobago). Faculty of Agriculture.
For primary bibliographic entry see Field 4C.
W91-03125

QUANTIFYING EROSION-CAUSING PARAMETERS IN A NEW ZEALAND WATERSHED.
South Canterbury Catchment Board and Regional Water Board, Limaru, New Zealand.
J. R. I. Cuff.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 99-112, 2 fig, 5 tab, 9 ref.

Descriptors: *Bank erosion, *New Zealand, *Sediment sources, *Slope degradation, *Soil erosion, Channel erosion, Limaru, Rainfall, Slope effects, Water pollution sources.

In New Zealand, excessive erosion in the upper mountain areas and subsequent sediment transport in rivers traversing the lower plains cause concern for those responsible for soil and water conservation. Factors causing erosion were investigated in the Orari catchment, a 550-sq km, steep, grass-covered watershed formed on greywacke/argillite and located in the east central part of South Island. Elevations range from 270-2000 m and mean annual rainfall is 1000 mm. Various sources of sediment were identified and the influence of various factors on sediment yield were examined. Slope, elevation, mean annual rainfall, amount and type of bare ground above, aspect, horizontal slope position, and geology were considered. The distri-

bution of all erosion types, except streambank erosion, is caused by on-site slope processes, which in turn are partly determined by several parameters (slope angle, altitude, mean annual rainfall, horizontal slope position, geology, and type of bare ground above). Of all the parameters influencing erosion distribution, man can influence only certain categories of bare ground. However, some of these bare-ground categories can exert considerable influence on erosion potential. Streambank erosion principally occurs in the channel wall, normally on flatter channel gradients, and is likely to be aggravated if there is detritus supplied from upstream. This erosion is less likely to be affected by on-site slope processes. (See also W91-03117) (Rochester-PTT)
W91-03126

WITHIN-FURROW EROSION AND DEPOSITION OF SEDIMENT AND PHOSPHORUS.
Agricultural Research Service, Kimberly, ID. Snake River Conservation Research Center.
For primary bibliographic entry see Field 3F.
W91-03127

USE OF SOIL SPECTRAL PROPERTIES FOR MONITORING SOIL EROSION.
Maryland Univ., College Park. Dept. of Agronomy.
For primary bibliographic entry see Field 7B.
W91-03128

PARTIAL AREA CONCEPT AND ITS APPLICATION TO THE PROBLEM OF SEDIMENT SOURCE AREAS.
Alberta Univ., Edmonton. Dept. of Geography.
For primary bibliographic entry see Field 2E.
W91-03129

DESIGN AND CONSTRUCTION CONSIDERATIONS FOR SEDIMENT SAMPLING OF STREAMFLOWS.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
J. A. Replogle, and S. A. El-Swaify.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 139-148, 5 fig, 13 ref.

Descriptors: *Analytical methods, *Bed-load discharge, *Sampling, *Sediment sampler, *Sediment sampling, *Suspended sediments, Comparison studies, Design criteria, Hawaii, Performance evaluation.

Sampling of runoff water sediments for the purpose of estimating sediment discharge often involves high sampling errors. In an effort to overcome the limitations of such samplers as Coshocton wheel samplers and H-flume combinations, a hypothetical, highly accurate sediment sampling system for both bedload and suspended particles is presented. Theoretical considerations in design of the ideal sampler are considered, performance of previous samplers is reviewed, and recommendations are made for building a practical model of the ideal sampler. In six field installations for storm flow rate and sediment sampling done in Hawaii, the sediment portion caused the most problems for a rotary, multistage sampler prototype. Although the system was judged to be capable of providing a fair to good sampling of water, bedload materials, and suspended sediments, many operational problems were encountered. These included soil aggregates that plugged the sampler slots, inundation by major floods and crop debris, and overtopping of the sample container. The following recommendations are made: (1) select a site with up to 1 m of overfall if possible; (2) fit a traversing mechanisms with a slotted sampler having two guard slots on each side, constructed and mounted with 10-deg downstream slope to help clear debris; (3) make the slot at least as wide as the maximum sample particle size to be collected; (4) provide an appropriate motor to ensure uniform speed of the traverser; and (5) use a cycle counter and diverter valve to control sample size. If timed samples are collected, then each sample pulse can be changed in volume by the chain drive speed. This will not change the sample volume collected. If the sampler can be constructed as described and time-delivery of the sample can be recorded, directed sampling from a channel overfall is possible without a flume contraction. (See also W91-03117) (Rochester-PTT)
W91-03130

ESTIMATING EROSION ON PLOT, FIELD, AND WATERSHED SCALES.
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
A. S. Rogowski, R. M. Khanbilvardi, and R. J. DeAngelis.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 149-166, 9 fig, 2 tab, 10 ref. EPA-ARS Interagency Agreement Funds EPA-IAG-D5-E763.

Descriptors: *Appalachian Region, *Sediment discharge, *Soil erosion, *Strip mines, Computer programs, Hydrologic models, Kriging, Mathematical models, Pennsylvania, Rehabilitation, Runoff, Statistics, Universal soil loss equation.

Because of high rainfall, many newly reclaimed stripmined sites in the Appalachian region of the United States will become susceptible to soil erosion before adequate cover can be established. The nature of the erosion problem on plots, fields, and watersheds was examined and a suitable scale to estimate potential and actual erosion was investigated. Three tracts, in Jefferson, Centre, and Northumberland Counties, Pennsylvania, were examined. A geostatistical technique for structural analysis was applied to these three sets of data and appropriate dispersion and estimation statistics were computed. Using kriging programs, the estimated distributions of potential erosion were analyzed for areas of different sizes and the results were compared with actual data from monitored runoff plots. Measured and estimated values were then compared with values computed using the computer erosion-deposition model of Khanbilvardi and associates. This model also was used to delineate contributing zones and principal areas of deposition at the Centre County site (Pine Glen). Having examined the apparent effects of different scales on erosion prediction over an area, it is concluded that estimation of erosion on a 1-ha basis likely will lead to the optimum prediction capability, especially on mined and reclaimed lands in Appalachia. This conclusion is based primarily on the results of structural analysis of soil loss data that suggest a workable continuity range of about 0.1 km ($3a = 3(0.035) = 0.105$), on an exponential variogram model, and on the examination of relative dispersion and extension statistics that are about the same or smaller than for a smaller or a larger area. The present findings, as well as the recent development of the erosion-deposition computer model, raise questions about the validity of extending the universal soil loss equation (USLE) predictions to larger areas, even when USLE is applied in conjunction with the sediment delivery ratio. (See also W91-03117) (Rochester-PTT)
W91-03131

INTERRILL EROSION RATES AND SEDIMENT CHARACTERISTICS.
Agricultural Research Service, Oxford, MS. Sedimentation Lab.
L. D. Meyer.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 167-177, 1 fig, 3 tab, 18 ref.

Descriptors: *Rill erosion, *Sediment erosion, *Sheet erosion, *Soil erosion, *Soil texture, Agricultural runoff, Iowa, Mississippi, Sediments, Storm runoff.

Rill and interrill erosion, often called sheet erosion, occur over so much of the land surface that they are hardly noticeable in comparison with the more spectacular soil losses from gully and stream channel erosion. Rill erosion often can be evaluated visually when it is especially serious, but interrill erosion is usually so inconspicuous that it must be evaluated experimentally. Experiments were conducted to evaluate interrill erosion over a wide range of soil and cropping conditions using a portable, multiple-intensity rainfall simulator. Most of the studies were conducted on typical agricultural fields (Mississippi, 15 soils; Iowa 3, soils) using rain intensities of about 10, 25, 67, and 105 mm/hr. Most of the research plots were on row sideslopes in row-cropped fields, typical interrill areas for intensively cropped agricultural land. Because interrill and rill erosion result from different erosive agents (rainfall and runoff, respectively), study of them separately rather than in combination is better for understanding complex soil erosion processes and developing effective erosion control practices. Interrill erosion rates as great as 50 t/ha-hr may result when intense rainstorms occur on poorly protected, highly erodible soil. Interrill erosion rates vary greatly, depending on soil type, rain intensity, and soil surface cover. The rates are affected to a lesser extent by slope steepness, prior land use, and amount of rainfall. The characteristics of sediment eroded from interrill sources vary greatly with soil texture and aggregation. Fine-textured soils often have coarse sediment because much of the sediment erodes as sizeable aggregates. The size distribution of sediment from aggregated soils can be estimated by laboratory procedures using samples of surface soil. The wet aggregates in sediment have densities of about 2 g/cu cm and they usually contain as much or more clay-size material as the original soil. Once eroded by raindrop impact from interrill areas, the aggregates are unlikely to be broken down further during transport through the cropland runoff system. Interrill erosion can be a major source of sediment from agricultural land and other disturbed land. Consequently, efforts to reduce interrill erosion have the potential to significantly reduce soil losses from such land. (See also W91-03117) (Rochester-PTT)
W91-03132

STOCHASTIC SIMULATION OF GULLY NETWORKS ON ERODED LAND.
Tokyo Univ. (Japan). Faculty of Agriculture.
M. Nakano, A. Takagi, and N. Haraguchi.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 178-187, 6 fig, 3 tab, 13 ref.

Descriptors: *Geomorphology, *Gullies, *Gully erosion, *Model studies, *Simulation, *Stochastic models, *Stream classification, Graphical analysis, Japan, Mathematical models, Stochastic process, Topography.

There are no widely accepted mathematical methods of quantitatively describing, simulating, and estimating gully networks. Gully networks were simulated with a model that starts with gully heads and draws the lines of the gullies downward through confluence. This is the opposite of the stream channel growth model used in geography, which starts with an outlet of channel networks and develops stream networks from there by headward growth of channels through branching. Gully networks generated by the model were compared with observed gully networks in Japan. Gully networks developed on a topographically concave slope can be described quantitatively with Strahler's stream channel ordering system. When the number of gullies of each order was plotted against gully orders on the ordinate of a logarithmic scale, the lines were slightly concave downward. When plotting the mean length of gullies of each order in the same fashion, the lines become conical and have a peak. A model in which the locations of gully heads are specified using uniform random numbers and gully lines drawn downward in zigzag fashion at angles selected with Gaussian random numbers can approximate the observed gully networks. Furthermore, the model suggests the following: (1) as gully networks grow, the number of gullies of each order increases in nearly the same ratio; (2) the mean length of gullies of lower order, however, decreases whereas that of gullies of the highest order increases; and (3) if flat surfaces were constructed, gully networks smaller in magnitude might develop such that the number of gullies of each order would decrease and the mean lengths of gullies of the second and third order would increase. (See also W91-03117) (Rochester-PTT)

W91-03133

SEDIMENT YIELD MODELING OF ROADWAYS.
New Mexico State Univ., Las Cruces. Dept. of Civil, Agricultural and Geological Engineering.
T. J. Ward.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 188-199, 3 fig, 2 tab, 36 ref.

Descriptors: *Erosion, *Forest watersheds, *Model studies, *Roads, *Sediment yield, California, Idaho, Long-term studies, Mathematical models, Montana, New Mexico, North Carolina, Storm runoff.

Historically, most erosion monitoring has focused on agricultural lands. In the last 25-30 yr, there has been a growing effort to address the problem of erosion from roadways, specifically those in forest environments. Empirical, long-term sediment yield studies have been conducted. More recently, mathematical modeling of long-term storm event erosion and sediment yield has been attempted. Two general approaches are currently in vogue: empirically derived regression models and physical process models. Research in the field of sediment yield monitoring as it relates to forested areas is reviewed and results of model validation are discussed. Sites in which the modeling validation was conducted are: Coweeta Experimental Watershed, North Carolina; mine haul roads in Montana and Idaho; California forest roads; and New Mexico forest roads. Comparisons among the sites indicated that the response of the Coweeta, California, and New Mexico road surfaces was, on average, quite similar. The mine haul roads responded with a bit more runoff from rainfall and significantly smaller sediment yields. One reason that yields were lower was gravel cover on the mine haul road sites. Modeling of roadways using physical process computer models (ROSED for Coweeta, ROSED and SIRSED for mine roads, and SIRSED for California roads) has proved to be an acceptable and representative means of estimating water and sediment yields, although there are some problems remaining. It is now possible to collect data, derive model parameters, and then make relatively good estimates of sediment yields from other rainfall events. (See also W91-03117) (Rochester-PTT)
W91-03134

UPLAND EROSION AND DOWNSTREAM SEDIMENT DELIVERY.
Stall (John B.) Ltd., Urbana, IL.
J. B. Stall.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 200-205, 3 fig 1 tab, 6 ref.

Descriptors: *Agricultural watersheds, *Channel detention, *Sediment yield, *Soil erosion, *Universal soil loss equation, Agricultural runoff, Geomorphology, Illinois, Incised channels, Mathematical analysis, Nonincised channels, Sediment sampler, Statistics.

The universal soil loss equation (USLE) is widely used for determining upland erosion and United States Agricultural Research Service soil scientists continue to conduct research to define more accurately the relevant factors. However, soil loss measurement as is done with plots using the USLE does not provide an accurate indication of sediment continuing downstream because much eroded sediment is deposited at the downhill end of the slope, beyond the measuring flume. In a study of 20 lake and pond watersheds in Illinois, it was concluded that the density of nonincised channels in a watershed reflected the amount of sediment entrapped in the watershed. (Nonincised channels are defined as those crossable by a farm tractor; incised (non-crossable) channels are routinely indicated on soil maps.) Most of the soil lost from a cultivated slope stops upon reaching the nonincised channel and thus is not relevant when calculating sediment input to streams. An equation was developed: S = -1.0 minus 0.25N, where S is the sediment entrapped in the watershed, varying from 0 to 8.0 t/ha/yr and N is the density of nonincised channels in the watershed, varying from 6.8 to 32.3 m/ha. The equation has a standard error for S of plus or minus 1.6 and a correlation coefficient R of 0.75 with 18 degrees of freedom. Although the equation is a statistical, not a physical relation, it is an indicator of the factors affecting sediment deposition within a watershed. In Illinois, and perhaps in the entire midwest, the density of nonincised channels in a watershed can aid in making a good estimate of sediment delivery to streams. (See also W91-03117) (Rochester-PTT)
W91-03135

ADJUSTING THE UNIVERSAL SOIL LOSS EQUATION FOR USE IN WESTERN EUROPE.
Faculte des Sciences Agronomiques de l'Etat, Gembloux (Belgium).
A. Bollinne.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 206-213, 4 tab, 9 ref.

Descriptors: *Erosion rates, *Europe, *Sediment yield, *Soil erosion, *Universal soil loss equation, Belgium, Comparison studies, Estimating equations, Slopes, Soil properties.

Tables and nomographs are available to calculate the values of the parameters of the universal soil loss equation (USLE) used in the United States. Research was carried out at a station in Sauveniere (Gembloux, Belgium) to verify these values. The soil, on a 6.5% slope, is a loess-derived silt loam in which an Orthic Hapludalf develops. Studies were conducted to verify the following factors: rainfall threshold values for erosion index 30 (EI30), correlation between EI30 and soil loss, soil erodibility factor (K), cover factor (C), and topographic factor (LS). Measurements are in progress to determine the support practice factor (P), but values of the USLE are used provisionally. A field comparison of use of the USLE with unmodified values versus the values determined as part of the present study showed that soil loss estimated with unmodified values used in the United States was too low. The modified USLE give better estimates but still underestimates soil loss on gentle slopes. In the unmodified USLE, the threshold value of 12.7 mm for rainfall definitely is too high., the correlation between EI30 and soil loss is low, and the slope factor seems to underestimate soil loss on gentle slopes (< 4%). Further research is needed to determine an erosion index more suitable than EI30 in western Europe, to quantify the values of other parameters such as C and P, and to verify the amplitude of variations of K-values for the loamy soils found there. The risk of soil loss can be estimated provisionally using the following equation (EI30 for rainfalls >= 1 mm): A = A sub jn x K sub m x LS/0.636 x CP, where A sub jn = soil loss on the bare reference plot (A sub jn = 0.19 EI30 + 0.64, with R = 0.58), K sub m = the adjusted K value (K sub m = 1.16 (K sub w minus 0.48) plus 0.43, where K sub w comes from a nomograph, and 0.636 = the value of LS from the reference plot. (See also W91-03117) (Rochester-PTT)
W91-03136

IMPACT OF EROSION ON LAND PRODUCTIVITY AND WATER QUALITY IN THE UNITED STATES.
Resources for the Future, Inc., Washington, DC.
P. Crosson.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 217-236, 3 tab, 14 ref.

Descriptors: *Agricultural watersheds, *Crop yield, *Soil erosion, *United States, *Water quality, Corn, Management planning, Regression analysis, Soil losses, Soybeans, Wheat.

Erosion from cropland causes two forms of damage: (1) loss of productivity of the cropland and (2) damage to downstream sites where the eroded material is deposited. Three questions are addressed here in a review of information about the United States: what is known about these two forms of erosion damage, what is known about the future magnitudes of these problems, and how serious are the current and future levels of these impacts. A study conducted using a regression approach with data from 616 counties growing corn and 299 counties growing soybeans demonstrated that erosion had a significant negative effective on the growth of corn and soybean yields, although the effect seems to have been concentrated in counties where erosion exceeded 11.2 t/ha. Erosion did not significantly retard the growth of wheat yields (data from 191 counties). The present approach produced results generally in agreement with those obtained using the Yield-Soil Loss Simulator and in a study conducted by Larson and associates. All three methods show yield reductions due to erosion over extended time scales. Little is known about the fate of eroded soil that is deposited near the source. However, there appears to be a consensus that its effects are negative; it clogs drainage ditches and irrigation canals, for example. The soil that enters streams also has deleterious effects, including increased turbidity, shortening of reservoir life spans, impeding navigation, and destruction of fish spawning habitats. The T-values used by the Soil Conservation Service (soil loss tolerances) may be too high. The case for policies to control erosion to reduce off-farm damage is strong, but the information base needed to devise cost-effective policies is weak. (See also W91-03117) (Rochester-PTT)
W91-03137

PHYSICAL COMPONENTS OF THE EPIC MODEL.
Agricultural Research Service, Temple, TX. Grassland, Soil and Water Research Lab.
J. R. Williams.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 272-284, 2 tab, 17 ref.

Descriptors: *Economic aspects, *Erosion-Productivity Impact Calculator, *Hydrologic models, *Model studies, *Plant growth, *Soil erosion, Erosion, Hydrology, Mathematical models, Nutrients, Resources Conservation Act, Soil temperature, Tillage, United States, Weather.

The EPIC (Erosion-Productivity Impact Calculator) model was developed by the Agricultural Research Service (United States Department of Agriculture) beginning in 1981. The model comprises physically based components for simulating erosion, plant growth, and related processes and economic components for assessing the cost of erosion, determining optimal management strategies, and son on. EPIC simulates the physical processes simultaneously and realistically using readily available inputs. The physical components of EPIC can be placed into seven major divisions: hydrology, weather, erosion, nutrients, plant growth, soil temperature, and tillage. EPIC simulations have been performed on 150 test sites in the continental United States and 13 test sites in Hawaii. Generally, the test results appear reasonable. The EPIC model is operational. It has produced reasonable results under a variety of climatic conditions, soil characteristics, and management practices. It also has demonstrated sensitivity to erosion in terms of reduced crop production. Although designed to be used in the Resources Conservation Act analysis of the current status of soil and water resources in the United States, EPIC has additional potential uses, including: (1) national-level conservation policy studies; (2) national-level program planning and evaluation; (3) project-level planning and design; and (4) as a research tool. (See also W91-03117) (Rochester-PTT)
W91-03138

SIMULATION OF INDIVIDUAL-STORM SOIL LOSS FOR MODELING THE IMPACT OF SOIL EROSION ON CROP PRODUCTIVITY.
Agricultural Research Service, Ames, IA.
J. M. Laflen, G. R. Foster, and C. A. Onstad.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 285-295, 5 tab, 20 ref.

Descriptors: *Crop yield, *Erosion-Productivity Impact Calculator, *Hydrologic models, *Model studies, *Soil erosion, Mathematical models, Model testing, Prediction, Storm runoff, Universal soil loss equation.

Determination of erosion's effect on crop productivity in the United States is to be made using an erosion, crop productivity model. An important part of the model--Erosion Productivity Impact Calculator (EPIC)--is soil erosion prediction. The soil erosion prediction component for EPIC is still undergoing development and testing. Current proposed equations for estimating soil erosion in EPIC are described here, including: modification of the rainfall erosivity factor, modification of the universal soil loss equation (USLE) crop and management factor (C, including prior land use subfactor, crop-canopy subfactor, surface-roughness subfactor, and residue-cover subfactor), and testing of storm loss simulation. Only portions of these equations are incorporated in the current EPIC. A simplified method for computing C values is now used. Three different approaches to computing C values are being compared, but eventually one will be chosen based on the results of the comparison. Newer information is now available concerning roughness and residue impacts on soil erosion. (See also W91-03117) (Rochester-PTT)
W91-03139

MODEL FOR QUANTIFYING INCENTIVE PAYMENTS FOR SOIL CONSERVATION IN CROPPING REGIONS SUBJECT TO WATER EROSION.
La Trobe Univ., Bundoora (Australia). School of Agriculture.
For primary bibliographic entry see Field 4D.
W91-03140

CROP YIELD REDUCTION DUE TO REDUCED PLANT AVAILABLE WATER CAUSED BY WATER EROSION.
Technische Univ., Munich (Germany, F.R.). Lehrstuhl fuer Bodenkunde.
For primary bibliographic entry see Field 4C.
W91-03144

ESTABLISHMENT OF PLANT COVER PARAMETERS FOR MODELLING SPLASH DETACHMENT.
National Coll. of Agricultural Engineering, Silsoe (England).
R. P. C. Morgan.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 377-383, 4 tab, 13 ref.

Descriptors: *Model studies, *Rainfall impact, *Soil erosion, *Soil-water-plant relationships, *Splash detachment, *Vegetation effects, England, Kinetic energy, Mathematical models, Parameter estimation.

The rate of splash detachment (DET) without plant cover varies with the kinetic energy (KE) of the rainfall. The relationship can be expressed by the power function DET = k KE to bth power, where k is an experimentally derived measure of the detachability of the soil, and b ranges in value from about 0.8 on sandy soils to 1.4 for clayey soils, with a value of 1.0 being reasonably representative and mathematically convenient. The effects of a plant cover can be accounted for by reducing the predicted detachment rate by a ratio that varies by the height, canopy cover, and ground cover of the plant assemblage. The ratio has a curvilinear relationship with the percentage canopy and ground cover, and this relationship suggests the following modeling equation: DET = k (KE.e to the -a.INCEP power) to the bth power, where INCEP is the percentage of rainfall that contributes to permanent interception and stemflow and therefore does not contribute to splash detachment and k is an index of soil detachability with the prevailing plant-soil complex and ranges from 0.03 to 0.15, with 0.06 being reasonably representative. This equation has been adopted for the splash detachment phase of a model to predict mean annual soil loss. Field measurements of the rate of splash detachment over 100-day periods were made between May 1973 and August 1979 in Bedfordshire, England, over a range of soils and plant covers. The factor b was negative whenever plant cover was present. Laboratory experiments were conducted to assess the effects of plant cover on the rate of splash detachment and on the volume and energy of rain reaching the ground surface. It was found that the modeling equation adequately represents the reductions in kinetic energy of rain as a result of interception by plant cover. More data are required on percentage of rainfall interception by different plants. Values of k can be determined experimentally for a series of storms, but they are relatively high for crops with large leaves on which raindrops coalesce and produce throughfall with large drop sizes. Under these conditions, b becomes negative. (See also W91-03117) (Rochester-PTT)
W91-03145

EFFECTIVENESS OF EI30 AS AN EROSIVITY INDEX IN HAWAII.
Hawaii Univ., Honolulu. Dept. of Agronomy and Soil Sciences.
A. Lo, S. A. El-Swaify, E. W. Dangler, and L. Shinshiro.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 384-392, 3 fig, 9 ref.

Descriptors: *Erodibility, *Hawaii, *Rainfall intensity, *Soil erosion, *Universal soil loss equation, Agricultural runoff, Annual precipitation, Estimating, Mathematical equations, Performance evaluation.

To employ the universal soil loss equation (USLE) in Hawaii, appropriate values for each USLE factor are needed. A study was conducted to test whether the erosivity index, defined as the product of storm kinetic energy and maximum 30-minute intensity (EI30), is applicable in Hawaii. Methods for its approximation were determined. Erosivity was investigated in three steps (1) studies of soil detachment under standard conditions, (2) studies of soil detachment, entrainment, and transport on standard runoff plots, and (3) these parameters were studied on field-scale plots in the absence of crop effects. Sand splash measured with calibrated sand splash cups correlated well with EI30. Linear regression relationships between EI30 and soil loss from standard bare plots and small watersheds also were well correlated. Because of the linear relationships between sand splash, soil loss, and EI30 index, it is concluded that the EI30 index is suitable for quantifying erosivity of Hawaiian rainstorms. A relationship between maximum 30-min and 60-min rainfall intensities was developed. The estimated EI30 index compared well with the true EI30 index. The comparison improved even further when storm EI30 indices were summed over the month and over the year. Against the EI30 index, rainfall totals on a storm, daily, monthly, seasonal, and annual basis, along with readily available Fournier and modified Fournier indices, were tested. Average annual rainfall was chosen as the best estimator of the average annual EI30 index. The estimation procedures were employed to develop a detailed isoerodent map for the island of Oahu. By using the annual rainfall amount estimation to refine and improve this map, it was possible to draw detailed isolines in areas where no data points previously existed. The map is recommended for use in the application of the universal soil loss equation in Hawaii. (See also W91-03117) (Rochester-PTT)
W91-03146

EROSION CONTROL IN URBAN RIVER VALLEYS: TORONTO, ONTARIO.
Surrey District, Vancouver (British Columbia).
For primary bibliographic entry see Field 4D.
W91-03147

RUNOFF EFFECTS ON THE EFFICIENCY OF RAINDROP KINETIC ENERGY IN SHEET EROSION.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Soils.
P. I. A. Kinnell.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 399-405, 3 fig, 11 ref.

Descriptors: *Kinetic energy, *Rainfall impact, *Rainfall-runoff relationships, *Sheet erosion, *Soil erosion, Australia, Erodibility, Infiltration, Thunderstorms, Vegetation effects.

Geographic applicability of an erosion model might increase through an approach that maintains a relatively simple structure, such as that of the universal soil loss equation (USLE), while adopting a more process-oriented approach to the selection of parameters. Such an approach was used in developing and applying a model for the effects of raindrop and surface water flows on sheet erosion. A model for total soil loss was developed that considered the effect of surface soil conditions (eg, erodibility and type and amount of vegetation) on the efficiency of the kinetic energy of raindrops and surface water flows. Tests were conducted in the field on bare fallow plots situated in Ginninderra, Australian Capital Territory. The rainfall events (n=43) ranged from long periods of low-intensity rainfall, which are common in winter, to intense summer thunderstorms. Runoff depths ranged from 0.2 to 57 mm. Infiltration rates ranging from 2-6 mm/hr were common during the low-intensity events, whereas infiltration rates of 15-20 mm/hr were common for storms in summer. A reasonable relationship was shown between soil loss and the product of (a) rainfall energy and (b) the positive difference between rainfall intensity and an approximation for the average infiltration rate for the event. (See also W91-03117) (Rochester-PTT)
W91-03148

RATE OF SOIL DETACHMENT BY OVERLAND FLOW, WITH AND WITHOUT RAIN, AND ITS RELATIONSHIP WITH DISCHARGE, SLOPE STEEPNESS, AND SOIL TYPE.
University of Science and Technology, Kumasi (Ghana). Faculty of Agriculture.
C. Quansah.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 406-423, 11 fig, 4 tab, 31 ref.

Descriptors: *Overland flow, *Rainfall impact, *Sediment discharge, *Slopes, *Soil erosion, Mathematical equations, Regression analysis, Rill erosion, Slope effects, Soil properties.

Studies on the four phases of the erosion process have focused mainly on splash detachment and transport. A laboratory study was conducted to measure detachment of particles by overland flow, with and without rain; to examine the effect of varying slope steepness and soil type on the relative contribution to detachment by overland flow and raindrop impact; and to establish power equations for the flow's detachment rate with slope steepness, discharge, and soil type. Detachment by overland flow without rain occurred primarily by rilling. Rainfall increased detachment rate, and there was a relatively even removal of particles from the eroding bed. By determining the amount of material detached by overland flow with and without rain, it was possible to calculate the relative contributions to total detachment by overland flow and by splash. On gentle slopes most detachment on the soils was by splash, whereas overland flow detached little soil. As slope increased, splash detachment increased gradually, but detachment by overland flow increased rapidly. Multiple regression techniques indicated a highly significant (p=0.001) correlation between overland flow and slope steepness and discharge. There is a critical slope steepness at which rainfall impact and overland flow contribute equally to detachment. At lower slopes, raindrop impact dominates, whereas at steeper slopes, flow dominates detachment. The critical slope steepness, knowledge of which is necessary to apply control measures for the appropriate detaching agent, is soil specific. New equations accommodating the effects of rainfall-runoff interactions and grain size effects were established in the course of this study, but they have not been

validated under field conditions to date. (See also W91-03117) (Rochester-PTT)
W91-03149

UNIVERSAL INDEX FOR CALCULATING RAINFALL EROSIVITY.
Institute of Soil Science and Yield Prediction, Sofia (Bulgaria).
N. G. Onchev.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 424-431, 3 tab, 23 ref.

Descriptors: *Rainfall impact, *Rainfall intensity, *Rainfall-runoff relationships, *Soil erosion, *Universal Index, Bulgaria, Erodibility, Erosion rates, Mathematical studies, Runoff.

Studies in various parts of the world have demonstrated the need for a more objective index than EI30 for calculating rainfall erosivity that will not be affected by regional differences in rainfall. A new index was developed based on two critical quantitative characteristics: quantity and intensity of rainfall not inducing runoff, used for separating the active erosive portion in every rainfall. The erosivity of each rainfall is determined by the active runoff-inducing part, which in Bulgaria represents the sum of the periods with an intensity > or = 0.180 mm/min and total quantity > or = 9.5 mm. On the basis of this regularity, the universal index (UI) could be deduced for calculating rainfall erosivity according to the following equation: R' = P/sq root of t, where R' = the universal index, P = quantity of rainfall > or = 9.5 mm, and t = the duration of rainfall with intensity > or = 180 mm/min. The UI is superior in terms of rainfall erosivity representativeness to all indices and characteristics of rainfall tested so far because it does not include those rainfalls that are incapable of producing erosion (i.e., P < 9.5 mm, intensity < 180 mm/min). (See also W91-03117) (Rochester-PTT)
W91-03150

CLASSES OF RELIEF SUSCEPTIBILITY FOR SURFACE EROSION.
International Inst. for Aerial Survey and Earth Sciences, Enschede (Netherlands).
E. Bergmsa.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 432-436, 1 fig, 2 tab, 7 ref.

Descriptors: *Land slope values, *Relief classification, *Soil erosion, *Soil physical properties, *Topography, Classification, Graphical analysis, Mapping, Rills, Slope effects.

Relief classes described in the Soil Survey Manual (U.S. Department of Agriculture) were used as the starting point in an attempt to develop a relationship to the length/steepness (LS) values according to the universal soil loss equation (USLE). This could not be done because the LS graphs run across the slope ranges of the relief classes. However, if classes described by combinations of slope length and slope steepness are considered, it appears possible to create classes that have only a limited variation of LS value. Ultimately, six relief steepness classes were related to erosion slope length classes so that hazard surveys could be conducted using mapping units on scales of about 1:10,000 and 1:50,000. Within each relief steepness class, the erosion slope length class (e.g., 12-30 m, 30-60 m, etc.) is associated with a 'step' value indicating the degree of erosion hazard. Tentatively, rill occurrence is estimated to increase soil loss by two to five or six steps. The ratio will depend strongly on the soil texture and steepness and the overland flow volume. It has been shown that rill hazard increases with overland flow volume, heavier texture, and slope steepness. (See also W91-03117) (Rochester-PTT)
W91-03151

SOIL ERODIBILITY FACTOR: A PERSPECTIVE.
Agricultural Research Service, Oxford, MS. Sedimentation Lab.
M. J. M. Romkens.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 445-461, 1 fig, 5 tab, 31 ref.

Descriptors: *Erodibility, *Reviews, *Soil erosion, *Soil properties, *Universal soil loss equation, K values, Ponding, Prediction, Simulated rainfall, Storms.

Since its introduction, the universal soil loss equation (USLE) has been gradually and systematically improved. The soil factor (usually referred to as the soil erodibility factor, K) is reviewed here, including: the soil factor in early soil loss equations (e.g., Zingg's, Smith's, and Smith and Whitt's); the USLE and the soil erodibility factor (definition, long-term values, fallow requirements); K values of natural runoff plots; rainfall simulation-based K values versus soil properties (K-factor determination, soil properties); and improving soil erodibility factor predictions. A universally applicable prediction equation for K values may not exist. Within the limits of the definition, however, accurate K-value estimates are best obtained from direct measurements on natural runoff plots if a sufficiently long observation period is used and unit plot conditions are met. Good estimates may be obtained from rainfall simulator studies provided storm weighting reflects the frequency pattern for the location and unit plot requirements are met. Indirect estimates, based on nomograph or other predictive relationships of soil properties, need to be considered carefully in relation to the type of soils for which these relationships were derived. In the absence of a suitable predictive model, substantial errors in K values may be made. Current evaluation techniques are based on a statistical relationship between the soil erodibility factor and a series of soil properties, antecedent conditions, and weather patterns. If a statistical relationship yields acceptable estimates of K values, an understanding of the underlying erosion processes is, from a utilitarian standpoint, not essential. The complexity of the erosion process precludes any simple calculation of the soil erodibility factor. Yet, some variability in K-value measurements can be reduced by estimating the effect of variation in antecedent soil water and soil surface roughness. The current procedure of excluding storms with less than 1.27 cm of rainfall can be improved by using predictions of ponding time and surface retention. (See also W91-03117) (Rochester-PTT)
W91-03153

PERCENT CROWN COVER RELATED TO WATER AND SOIL LOSSES IN MOUNTAINOUS FOREST IN THAILAND.
Kasetsart Univ., Bangkok (Thailand). Faculty of Forestry.
N. Ruangpanit.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 462-471, 5 fig, 3 tab, 10 ref.

Descriptors: *Forest watersheds, *Soil erosion, *Soil-water-plant relationships, *Thailand, *Vegetation effects, Chingmai, Litter, Mountain streams, Runoff, Soil losses, Watershed management.

Conservationists have long recognized that living plants and litter reduce runoff and erosion. A study was conducted in northern Thailand at the Doi Pui, Kog-Ma Watershed Research Station, Chingmai (elevation 1,350 m) with the aim of determining how different densities of crown cover affect runoff and erosion. There were two objectives: (1) to determine the specific crown cover required for minimizing water and soils losses and (2) to establish the density limits to which crown cover may be altered without losing its effectiveness for watershed protection. Sample plots were 4 x 20 m and were located on a southwest-facing 20-25% slope of the hill evergreen forest. Twelve regression equations were developed to show runoff and erosion as functions of rainfall under various percentages of crown cover. Both runoff and erosion increased with increasing amounts of rainfall and decreased with increasing percent crown cover, particularly as crown cover declined from 70%. The minimum amount of rainfall that caused erosion was 10 mm. The maximum infiltration capacity or soil water absorption to fulfill the demand of depression storage and establish an initial quantity of surface detention was equivalent to about 5 mm of rainfall. Erosion varied directly with runoff in a curvilinear relationship. One cu m/ha of surface runoff would cause about 3 kg/ha of soil loss. Erosion and runoff increased with rainfall intensity, rapidly when intensity exceeded 20 mm per hour and crown cover was reduced below 70%. The ratio of rainfall intensities of 0-10, 10-20, and > 20 mm/hr to cumulative soil loss was 1:4:8 and to runoff was 1:2:3.5. Runoff and erosion rates also increased with rainfall duration. As crown cover was reduced below 70%, they increased markedly, particularly with 60-min and longer rainfall durations. There was a close and direct relationship between crown cover and surface runoff or soil erosion, but crown cover had a minor effect on the total volume of surface runoff and soil erosion. In managing forest land, especially in areas designed for watershed protection purposes, the specific crown cover required to minimize surface runoff and soil erosion should be at least 70% and in combination with minimum bare soil openings. (See also W91-03117) (Rochester-PTT)
W91-03154

PRELIMINARY ANALYSIS OF RUNOFF AND SOIL LOSS FROM SELECTED LONG-TERM PLOTS IN AUSTRALIA.
Soil Conservation Service of New South Wales, Sydney (Australia).
K. Edwards.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 472-479, 2 fig, 4 tab, 14 ref.

Descriptors: *Agricultural practices, *Agricultural runoff, *Australia, *Soil erosion, *Vegetation effects, Long-term studies, Model studies, Pastures, Prediction, Universal soil loss equation, Wheat.

The universal soil loss equation (USLE) may not be valid or useful were large soil losses are infrequent but account for most of the total soil loss over the long term. In some Australian plots where data have been collected for up to 30 yr, preliminary analysis shows a heavily skewed distribution of soil loss. Data now are being collated from studies in New South Wales (Australia) that have been under way since the 1940s. Analysis of the data has three major aims: to provide quantitative measures of soil loss, to evaluate the USLE's applicability to Australian conditions, and to provide the basis for development, if necessary, of a soil loss prediction model for Australia. Plots of 100 sq m were enclosed by wooden planks and fitted with an apron and sill at the lower end. Runoff is led into a silt collection box. Such plots were established at Gunnedah and Wagga in the wheat belt of New South Wales; slopes of the plots were, respectively, 8.5 and 8.0 percent and annual rainfall averages 644 mm and 561 mm. The treatments imposed on the plots included both permanent pasture and a wheat rotation (wheat every second year). Although only a small proportion of the results from these runoff and soil loss trials are considered, a few trends are obvious. Large losses are infrequent but contribute most of the total losses. As a consequence, the concept of average annual losses is not very meaningful and may preclude use of the USLE. The results also demonstrate the protection provided by growing or inert vegetative material. Soil losses from cropped plots far exceed those from the pasture plots. Within the cropping rotation, significant losses are restricted to periods when ground cover is reduced by cultivation. More data from a wider range of centers will be needed to determine whether the USLE is applicable to Australian conditions. (See also W91-03117) (Rochester-PTT)
W91-03155

MODIFYING THE UNIVERSAL SOIL LOSS EQUATION FOR FOREST LAND.
Forest Service, Atlanta, GA.
G. E. Dissmeyer, and G. R. Foster.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 480-495, 15 fig, 3 tab, 14 ref.

Descriptors: *Forest soils, *Forest watersheds, *Soil erosion, *Universal soil loss equation, *Vegetation effects, Fabric dams, Field tests, Organic matter, Rill erosion, Sheet erosion, Soil properties.

The universal soil loss equation (USLE) has evolved as the major tool for estimating sheet and rill erosion. The subfactor approach has evolved as use of the USLE has expanded and has provided needed flexibility. The subfactor allows estimates of erosion to be made systematically where no data are available, based upon an evaluation of site-specific conditions. Starting in the spring of 1977, various United States Department of Agriculture agencies pooled their efforts to produce a new a procedure for assigning cover-management-factor values to forest land. The major subfactors operating in many forests are (1) amount of bare soil, (2) canopy, (3) soil reconsolidation, (4) high organic matter content, (5) fine roots, (6) residual binding effect, (7) onsite storage, (8) steps, and contour tillage. The USLE needs to be adapted before it is adopted for use in new situations. If this is done, erosion estimates will be more accurate. Although the traditional approach of plots and watersheds is always best for validating the USLE, it requires significant financial and technical resources and equipment. An alternative is the use of fabric dams, which can effectively and inexpensively measure and demonstrate erosion from a variety of conditions. Fabric dams are constructed at the toe of plots using erosion-control fabric that allows water through while filtering out soil particles. Before the USLE can be used in new situations, rainfall erosivity (R) and soil erodibility (K) factors need to be developed using procedures given in Agriculture Handbook 537. (See also W91-03117) (Rochester-PTT)
W91-03156

RESEARCH ON THE UNIVERSAL SOIL LOSS EQUATION IN INDIA.
Central Soil and Water Conservation Research and Training Inst., Dehra Dun (India).
G. Singh, R. Babu, and S. Chandra.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 496-508, 3 fig, 6 tab, 23 ref.

Descriptors: *Cultivated lands, *India, *Model studies, *Soil erosion, *Universal soil loss equation, Comparison studies, Performance evaluation, Research facilities, Soil management, Watershed management.

Of India's 328.8 million ha, about 175 million ha are affected by soil erosion and other land degradation problems. About 80 million ha of agricultural land are affected by erosion. Erosion research on runoff plots in India started as early as 1929. Soils on runoff plots in India include alluvial, black, regosal, red, and lateritic and deep lateritic soils. There are eight soil conservation research demonstration and training centers as well as other institutions collecting data concerning universal soil loss equation (USLE) factors (i.e., rainfall erosivity (R), soil erodibility (K), slope-length (L), slope-gradient (S), topographic (LS), cropping management (C), and soil conservation practice (P)). Considerable soil loss data has been collected at the soil conservation research centers in India, but the USLE remains the best model available, with some modifications supported by research. Data collected at the Central Soil and Water Conservation Research and Training Institute, Dehra Dun, and its centers, as well as by other agencies, such as the state governments' research centers and universities, have been used for developing various USLE factors. In some cases, the factors developed are only first approximations. Insufficient research data are available to develop a new prediction equation model specifically for Indian conditions. At present, specific values of some USLE factors are available that can be used to assess the gross soil erosion under different management conditions in India. (See also W91-03117) (Rochester-PTT)
W91-03157

APPLICABILITY OF THE UNIVERSAL SOIL LOSS EQUATION (USLE) AND MODIFIED USLE IN HAWAII.
Agricultural Research Service, Boise, ID. Northwest Watershed Research Center.
K. R. Cooley, and J. R. Williams.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 509-522, 4 fig, 4 tab, 11 ref. Soil Conservation Service Cooperative Agreement 12-14-5001-320.

Descriptors: *Agricultural runoff, *Agricultural watersheds, *Hawaii, *Soil erosion, *Universal soil loss equation, Model studies, Performance evaluation, Pineapple, Sugarcane, Vegetation effects.

Lack of information on actual soil erosion and its relationship to causal factors in Hawaii has restricted the adaptation or modification of methods used elsewhere to estimate erosion. Mainland-derived equations, such as the universal soil loss equation (USLE), generally overestimate soil loss compared to observations. Rainfall, runoff, and erosion data were obtained over 7 yr from 5 small Hawaiian agricultural watersheds (0.615-2.84 ha). The objectives were to estimate values of the crop factor (C) for pineapple and sugarcane from measured data and to determine the applicability of the USLE and the modified USLE (MUSLE) to Hawaii. Generally, the factors most difficult to estimate when initially applying the USLE or MUSLE are C and the soil erodibility factor (K). The other factors are based on measured precipitation or runoff, or they can be estimated from observations or topographic maps. In the present study, C factors were estimated by measuring or using previously determined values of the support practice factor (P), the rainfall erosion index (R), the slope length (L) and steepness (S) factors, K, the storm runoff volume (Q), and the peak runoff rate (q sub p), and then solving for C. Overall, the C values determined for Hawaiian watersheds in this way are lower than those given in the Soil Conservation Service handbook. C values for pineapple tend to be slightly higher than those for sugarcane for the same hydrologic soil group, although the range of values may be the same. A data-based comparison of the USLE and MUSLE methods of estimating soil losses indicates that the USLE predictions will be higher than the MUSLE predictions when equal values of K, LS, P, and C are used. This suggests that C values near the lower end of the range should be selected for the USLE and higher values for the MUSLE. Estimates of total soil loss (annual average by USLE) ranged from 1.96 to 4.23 t/acre/yr for the five watersheds. Average observed losses ranged from 0.36 to 4.35 t/acre/yr for the same five watersheds. (See also W91-03117) (Rochester-PTT)
W91-03158

EXPERIMENTALLY DERIVED MODIFICATION OF THE USLE.
Agricultural Research Service, Oxford, MS. Sedimentation Lab.
C. K. Mutchler, and C. E. Murphree.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 523-527, 8 ref.

Descriptors: *Cultivated lands, *Slope effects, *Soil erosion, *Topography, *Universal soil loss equation, Errors, Kinetic energy, Mathematical equations, Rainfall impact, Tillage, United States.

The universal soil loss equation (USLE) was developed primarily from data collected in the midwestern United States to predict erosion on valuable farmland in that region. Erosion on slopes less than 3% was not recognized as significant. Studies were conducted on erosion on flat lands and it was found that this can be serious; high rainfall rates are especially significant for soil erosion on low slopes. Based on studies of the individual factors under flat land conditions, the USLE is modified to A = R Rc K Kc L S C1 C2 C3, C4, C5, P, where the A is the estimated soil loss and R, K, L, S, and P are rainfall erosion index, soil erodibility, slope length, slope steepness, and erosion control processess. The subscripted values Rc and Kc represent correction factors to account for the effects of low slope on the rainfall erosion index and slope length, respectively. C1, C2, C3, C4, and C5 subfactors of the crop factor covering, respectively, land use residual, incorporated residual, tillage intensity and recency, macroroughness, and cover-canopy effects. Several recommendations are made for applying the USLE on flat lands, including: (1) using a new equation for the kinetic energy portion of the R factor (although the current equation does not cause any significant error in the United States); (2) using proposed values of Rc to correct the USLE for use on low slopes under high rainfall conditions until a better formulation of Rc = f(R, theta) can be developed (theta = slope steepness); (3) using Kc to represent variable soil erodibility when the C subfactors are used; otherwise, using the constant K with variable soil erodibility included in the average annual cropstage C factor; (4) using a new equation to compute the exponent for computing the slope-length factor from slope length on slopes of less than 3%; and (5) continuing development of the C-subfactor system and extend it for all crops and management systems. (See also W91-03117) (Rochester-PTT)
W91-03159

EXPERIMENTAL DATA ON RUNOFF GENERATION.
Katholieke Univ. Leuven (Belgium). Lab. voor Experimentele Geomorfologie.
For primary bibliographic entry see Field 2E.
W91-03160

IMPACT OF CHECK DAMS ON STEEP MOUNTAIN CHANNELS IN NORTHEASTERN TAIWAN.
Taiwan Forestry Research Inst., Taipei.
For primary bibliographic entry see Field 4D.
W91-03161

NEW MATHEMATICAL MODEL OF SOIL EROSION AND DEPOSITION PROCESSES WITH APPLICATIONS TO FIELD DATA.
Griffith Univ., Nathan (Australia).
C. W. Rose, and D. M. Freebairn.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 549-557, 2 fig, 13 ref.

Descriptors: *Australia, *Deposition, *Hydrologic models, *Mathematical models, *Model studies, *Soil erosion, *Universal soil loss equation, Erosion control, Mulches, On-site data collections, Soil properties.

The universal soil loss equation (USLE) is helped in the United States by the extensive data base available for important agricultural regions. Other countries have difficulty in amassing such a data base, and there is some uncertainty in predictive use of the USLE, especially where its hydrologic simplicity may limit its utility, as is the case with vertisols. Research on deterministic, process-oriented models ultimately may complement the USLE and relieve such limitations. A new approach is outlined here that is based on the principles of hydrology and erosion and deposition processes. Based on a theoretical analysis, an equation was developed for total sediment loss per unit plane width from a given area. This equation involves total sediment loss (Qs), the slope of the plane (S), a nondimensional factor for the efficiency of the sediment entrainment process (nu), the fraction of the soil surface unprotected by mulch or stone (Cr), the total runoff per unit area for the specific runoff event (RT), and the length of the plane in meters (L). The simplified theory of this equation was applied to field experiments in which Qs and RT were measured or estimated, S varied from 5-7 percent, and L was approximately 30 m. The experiments were carried out on soils of high clay content at two sites in the Darling Downs, Queensland, Australia. One soil was a vertisol. Soil loss in these experiments could be on the order of 200 tons/ha in a single runoff event with bare soil. The exposure fraction Cr (Ce for mulch experiments) was varied by the use of surface stubble from previous crops. Cr varied from zero (complete cover) to 1.0 (bare soil). The value of nu was calculated for all major runoff events at the two sites over 6 yr of record for a limited range of slope but a wide range of Cr. A strong functional dependence of nu on Cr was noted. Entrainment

efficiency, nu, fell from approximately 0.7 at Cr = 1 to approximately 0.25 at Cr = 0.9. Thus, a cover of only 10% reduced soil loss by almost two-thirds, supporting the well-known conservation effectiveness of stubble mulch. (See also W91-03117) (Rochester-PTT)
W91-03162

EXPERIMENTAL MODEL OF EVALUATING SOIL EROSION ON A SINGLE-RAINSTORM BASIS.
Istituto Sperimentale per lo Studio e la Difesa del Suolo, Florence (Italy).
G. Chisci, M. Sfalanga, and D. Torri.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 558-565, 2 fig, 2 tab, 15 ref.

Descriptors: *Italy, *Model studies, *Soil erosion, *Storm runoff, *Universal soil loss equation, Forecasting, Kinetic energy, Rainfall impact, Simulated rainfall.

Soil erosion is widespread and severe in Italy. The National Research Council sponsored a 5-yr project on soil conservation that ended in June 1982. As part of this project studies were conducted of soil erosion mechanics with a view toward supplying information for use in soil loss models based on erosion mechanics. Laboratory experiments, field experiments with a rainfall simulator, and field experiments with natural rainfall were performed. The model used is based mainly on soil availability (alpha) and force of transport of runoff (F). Availability is a balance between some subfactors, namely raindrop and runoff detachment rates and erosion rate. An estimator of F was proposed and tested with satisfactory results, although further tests are needed. Raindrop detachment rate depended mainly on rain kinetic energy and soil characteristics. Runoff detachment rate was proportional to runoff shear stress. Both detachment rates need to be tested further, especially that for runoff. The model has some weak points: (1) the force of transport and the shear stress are estimated through formulas derived under conditions of uniform flow at a steady state and (2) runoff characteristics strongly affect the model. However, since the model is intended to forecast soil loss during critical events, simplifications in forecasting runoff are to be expected. The experimental results indicate that the main factors and subfactors defining the universal soil loss equation (i.e., kinetic energy of rain, particle size distribution, and organic matter content) are related strongly to erosion as all of them are implicitly or explicitly present in the model. The model is far from operative, but the results so far indicate that it shows promise for forecasting soil loss during critical events, a type of forecasting of great importance for the Italian environment. (See also W91-03117) (Rochester-PTT)
W91-03163

SPATIAL SIMULATION TO AID IN EVALUATING AND TREATING EROSION AND WATER QUALITY PROBLEMS AFFECTING LAKE ERIE.
Purdue Univ., Lafayette, IN. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W91-03164

GULLY SIDEWALL DEVELOPMENT IN NEW SOUTH WALES, AUSTRALIA.
Macquarie Univ., North Ryde (Australia). School of Earth Sciences.
R. J. Blong.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 574-584, 6 fig, 14 ref.

Descriptors: *Australia, *Bank erosion, *Erosion control, *Erosion rates, *Gully erosion, *Soil conservation, *Soil erosion, Headwaters, Management planning, Model studies, Rainfall impact.

Discontinuous gully headcut erosion has been fairly well documented, but comparatively little attention has been paid to the role of gully sidewalls. In three areas in New South Wales (Australia), sidewall erosion may be responsible for more than half the total volume of gully erosion. Recent results of studies in this area are summarized, the relationship between sidewall and erosion rates is demonstrated, the connection between sidewall evolution and headcut retreat is illustrated, and some implications for gully studies and soil conservation are discussed. Relatively simple, rapid field and photographic measurements were used, but they suggest several tentative conclusions and implications for soil conservation. More than half the sediment derived from a gully system may result from sidewall erosion. In some gully systems, the proportion resulting directly from linear incision may be relatively small. Gully sidewall development in some areas of New South Wales, and very likely elsewhere, is dominated by the growth, decay, and stabilization of flutes. Processes of rainsplash and slopewash are believed to dominate the active stage of gully sidewall development, but this cannot be demonstrated yet. Assuming that surface area ratio is an adequate surrogate for sidewall erosion rate, some readily identifiable segments of gully sidewall erode three or more times faster than other identifiable segments. In a simple gully system, the rate of erosion would increase from the headcut to some point downgully, beyond which it declines. However, most gullies have a relatively complex growth form to which this simple model is less applicable. At a given segment of gully sidewall in the Razorback area (80 km SW of Sydney), maximum erosion rates are reached perhaps 20-40 yr after sidewall initiation by headcut retreat. The erosion rate for the segment then declines to a relatively low value when the sidewall reaches a stable angle with a plant cover (perhaps as many as 50 yr after initiation. Two important implications for soil conservation stem from these observations: (1) installation of a successful gully headwall control structure will not halt downgully sediment yield in the short term and (2) because sediment yield is largely derived from portions of the gully sidewall positioned on the rising limb of the bell-shaped gully natural history curve (10-30 yr), there is probably little point in spending conservation money reshaping gully sidewalls that have progressed to the falling limb of the curve (30-50 yr) because erosion rate already is declining naturally. (See also W91-03117) (Rochester-PTT)
W91-03165

SIMPLIFIED SEDIMENT YIELD MODEL FOR SMALL AREA DISTURBANCES ON SURFACE-MINED LANDS.
Simons, Li and Associates, Inc., Fort Collins, CO.
For primary bibliographic entry see Field 4C.
W91-03166

SOIL EROSION AND ITS CONTROL IN DEVELOPING COUNTRIES.
Food and Agriculture Organization of the United Nations, Rome (Italy).
For primary bibliographic entry see Field 4D.
W91-03175

RIVER MEANDERING.
For primary bibliographic entry see Field 2E.
W91-03203

BOUNDARY SHEAR STRESS AND SEDIMENT TRANSPORT IN RIVER MEANDERS OF SAND AND GRAVEL.
California Univ., Berkeley. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 2E.
W91-03204

SEDIMENTARY CONTROLS ON CHANNEL MIGRATION AND ORIGIN OF POINT BARS IN SAND-BEDDED MEANDERING RIVERS.
Tsukuba Univ. (Japan). Environmental Research Center.
For primary bibliographic entry see Field 2E.
W91-03205

FLOW IN MEANDERING CHANNELS WITH NATURAL TOPOGRAPHY.
Washington Univ., Seattle. Geophysics Program.
For primary bibliographic entry see Field 2E.
W91-03206

SEDIMENT TRANSPORT AND SORTING AT BENDS.
Saitama Univ., Urawa (Japan). Dept. of Foundation Engineering.
S. Ikeda.
IN: River Meandering. Water Resources Monograph 12. American Geophysical Union, Washington. 1989. p 103-125, 12 fig, 34 ref. Ministry of Education and Culture of Japan Grant 59020003.

Descriptors: *Bed load, *Channel morphology, *Geomorphology, *Mathematical models, *Meanders, *Model studies, *Sediment sorting, *Sediment transport, *Topography, Channel flow, Channel scour, Particle size.

Equilibrium sorting of bed material transported as bedload and bed topography were considered for uniformly-curved channels. A formula for lateral bedload transport was developed, including the effects of secondary flow and gravity due to lateral bed slope and was successfully applied to a natural river. The coarsening of sediment size toward the outside bank was predicted. The major agent for the sorting was associated with the tendency for coarser grains to feel a larger ratio of lateral gravitational force to fluid force than finer grains. The bed topography was calculated so as to allow for coupling with the lateral sorting. The results indicated that sorting suppressed local scour near the outer bank. Application to the lower Wabash River indicated that the maximum depth of scour is reduced by about 36% due to sorting. (See also W91-03203) (Author's abstract)
W91-03207

SEDIMENT CONTROL BY SUBMERGED VANES: DESIGN BASIS.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
A. J. Odgaard, and A. Spoljaric.
IN: River Meandering. Water Resources Monograph 12. American Geophysical Union, Washington. 1989. p 127-151, 13 fig, 2 tab, 21 ref. NSF Grant MSM-8611147.

Descriptors: *Bank erosion, *Channel erosion, *Channel morphology, *Design criteria, *Erosion control, *Geomorphology, *Sediment erosion, *Vanes, Theoretical analysis.

Studies were conducted to develop vanes to protect against bank erosion. Preliminary investigations showed that vanes are effective in deepening the center portion of a straight channel. Attempts to verify and improve critical design relations of vanes yielded two equations that provide reasonable, gross estimates of horizontal lift and drag on thin, flat, small-aspect ratio riverbed vanes at angles of incidence up to about 20 degrees. Although low Froude number wing theory predicts that cambering of the vane should increase lift, the experimental data showed little improvement. This was explained by boundary-layer separation around the vanes, which is more pronounced around cambered vanes than around thin, flat vanes. Vane thickness increased the size of the separation zone on the rear side of the vane which caused a decrease of lift. The theory predicted a significant increase of lift with decreasing flow depth/vane height ratio within the range 2 to 4 (the range for which vane systems are designed). The increase was due to suppression of the tip vortex by the free surface, which results in an increase of the pressure difference between the vane surfaces. The experimental data confirmed this trend. The difference between theory and experiments was attributed to boundary-layer separation, which was not accounted for in the theory. The velocity data suggested that the lateral spacing of vanes in a layout should not exceed 1.5 to 2 flow depths if the layout is to produce a common circulation. The longitudinal spacing of vanes depends on the rate of decay of induced circulation. Vanes must be aligned in reference to the trailing-vortex line produced by upstream vanes. Applica-

tion of the present findings applies to horizontal rigid beds, and performance of vanes on movable beds is currently being studied. (See also W91-03203) (Geiger-PTT)
W91-03208

ANALYSIS OF A 2-D BED TOPOGRAPHY MODEL FOR RIVERS.
Waterloopkundig Lab. te Delft (Netherlands).
For primary bibliographic entry see Field 2E.
W91-03209

LINEAR THEORY OF RIVER MEANDERS.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
H. Johannesson, and G. Parker.
IN: River Meandering. Water Resources Monograph 12. American Geophysical Union, Washington. 1989. p 181-213, 7 fig, 2 tab, 40 ref, append.
NSF Grants MSM-8311721-02 and INT-8412678.

Descriptors: *Channel morphology, *Geomorphology, *Mathematical models, *Meanders, *Model studies, *River beds, *Topography, Bank erosion, Channel flow, Resonance, Sediment transport, Theoretical analysis.

A mathematical model was developed for the calculation of flow field and bed topography in curved channels with an erodible bed. A small perturbation approach is used to linearize the governing equations, which retain the full coupling between the flow field, the bedload transport, and the bed topography. This coupling is shown to increase significantly the lateral bed slope in the upstream part of a channel bed, even beyond the value for fully developed bed flow which is approached in the downstream part of a channel bend. The coupling is also shown to give rise to resonant behavior for certain combinations of input variables. For a certain combination of input variables, curvature forces a perturbation of alternate bar type to the flow. Overdeepening is explained in terms of the wavelength and damping obtained with a linear analysis of the governing equations for the steady state case, assuming zero curvature. If the present model is used to carry out this analysis, the governing equations are the same as for the alternate bar analysis, except that unsteady terms are dropped. The predicted flow field and bed topography compare very well with laboratory data. Further, assuming the banks to be erodible, the model is used to predict wavelengths of river meanders. The results compare favorably with both laboratory and field data. (See also W91-03203) (Author's abstract)
W91-03210

STUDIES ON QUALITATIVE AND QUANTITATIVE PREDICTION OF MEANDER CHANNEL SHIFT.
Hokkaido Univ., Sapporo (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-03211

FINITE AMPLITUDE DEVELOPMENT OF ALTERNATE BARS.
Public Works Research Inst., Tsukuba (Japan). River Hydraulics Div.
For primary bibliographic entry see Field 2E.
W91-03212

ALTERNATE BARS AND MEANDERING: FREE, FORCED AND MIXED INTERACTIONS.
Genoa Univ. (Italy). Inst. of Hydraulics.
For primary bibliographic entry see Field 2E.
W91-03213

EVOLUTION AND STABILITY OF ERODIBLE CHANNEL BEDS.
Washington Univ., Seattle. Geophysics Program.
For primary bibliographic entry see Field 2E.
W91-03214

OBSERVATIONS ON SEVERAL RECENT THEORIES OF RESONANCE AND OVERDEEPENING IN MEANDERING CHANNELS.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 2E.
W91-03215

BAR AND CHANNEL FORMATION IN BRAIDED STREAMS.
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
For primary bibliographic entry see Field 2E.
W91-03216

TOPOGRAPHIC RESPONSE OF A BAR IN THE GREEN RIVER, UTAH TO VARIATION IN DISCHARGE.
E. D. Andrews, and J. M. Nelson.
IN: River Meandering. Water Resources Monograph 12. American Geophysical Union, Washington. 1989. p 463-485, 9 fig, 12 ref.

Descriptors: *Channel morphology, *Geomorphology, *Mathematical models, *Meanders, *Model studies, *Numerical analysis, *Sediment transport, Channel flow, Flood discharge, Green River, Sediment discharge, Sediment erosion, Utah.

A fully nonlinear numerical model was used to analyze the characteristics of flow and sediment transport in a reach of the Green River near Ouray, Utah. The reach has gentle, but complicated curvature and contains a prominent mid-channel bar composed of medium to fine sand. Bankfull channel width and area vary significantly through the study reach. Model calculations were compared with the observed lateral distribution of unit discharge and mean annual bed-material transport and were found to be in excellent agreement. Adjustment of channel topography over a period of time at a constant discharge was calculated at discharges of 50 cu m/sec (approximately 40% of the mean annual flow), 275 cu m/sec, and 475 cu m/sec (approximately the bankfull discharge). Each simulation began with the same topography, which was surveyed at a discharge of approximately 275 cu m/sec, 5 weeks after a peak discharge of approximately 620 cu m/sec. Gradually decreasing flows following the flood peak and significant bed-material transport rates tended to maintain a channel topography in equilibrium with the discharge. Bar topography was enhanced greatly at a discharge of 475 cu m/sec. Sediment accumulated on the bar surface and was eroded from the side channels except in the downstream part of the secondary channel where some sediment was deposited. At a discharge of 50 cu m/sec, the bar crest stood nearly 1 m above the water surface, and there was no flow through the secondary channel. More than 1 m of material accumulated in the primary channel along most of the length of the bar, over a period of two days. A comparison of aerial photographs taken of the Ouray reach between 1963 and 1987 showed very little change in the bar, in spite of the fact that bar topography tended to adjust relatively quickly to changes in river discharge. Neither established vegetation nor debris had a stabilizing effect upon the bar. Long-term stability of the bar appeared to be due to a constriction in channel width and area located slightly downstream of the bar apex. (See also W91-03203) (Author's abstract)
W91-03217

EVALUATION OF SEDIMENT TRAPS IN LAKE ST. CLAIR, LAKE ONTARIO, AND HAMILTON HARBOUR.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 2H.
W91-03402

QUANTITATIVE MODEL OF THE DISPERSAL OF DETRITAL INPUTS AND MINOR COMPOSITIONAL COMPONENTS IN LAKE MICHIGAN SEDIMENTS.
Michigan Univ., Ann Arbor. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2H.
W91-03408

WHY SEDIMENTS DEPOSIT IN LINED CHANNELS.
Irrigation and Power Research Inst., Amritsar (India).
T. C. Paul, and V. S. Sakhuja.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 5, p 589-602, September/October 1990. 7 fig, 2 tab, 17 ref.

Descriptors: *Canal design, *Canal linings, *Channel accretion, *Drainage engineering, *Irrigation engineering, *Mathematical analysis, *Sedimentation, Cross-sections, Deposition, India, Irrigation canals, Mathematical equations, Roughness coefficient, Sediment discharge, Sediment transport, Waterlogging.

In order to alleviate waterlogging, minimize maintenance costs, and improve conveyance efficiency, numerous unlined channels in India are replaced by parallel-running, cup-shaped (round-bottom), brick-lined (rigid boundary) channels. The operation of these newly-lined channels manifests sediment deposition all along the wetted perimeter. This is quite surprising because: (1) the grade and concentration of sediment entering these lined channels (from their parent unlined branch canals) remain the same as in the case of unlined channels; (2) water surface or bed slopes are unchanged because the channel command is the same; and (3) the roughness coefficient rather appreciably decreases on account of the lining. Sediment distribution in lined channels could probably be attributed to workmanship, quality of materials used, provision of steps at the channel bottom, and shape of cross-section adopted. The most efficient shape of conveyance of sediment transport with no deposition is the rectangular section placed with its longer side horizontal, followed by the conventional trapezoidal section. The cup-shaped section should not be used since it is the least efficient for sediment transport. Criteria for determining the limiting concentration of transported sediment can be calculated by means of a mathematical equation, and infers that the trapezoidal section is superior to a cup-shaped section for sediment transport as bed load. The suggested function for the limiting bed load concentration in rigid boundary channels should be given a fair trial. (Author's abstract)
W91-03419

LANDSLIDES IN THE UPPER JORDAN GORGE.
Haifa Univ. (Israel). Dept. of Geography.
M. Inbar, and M. Even-Nir.
Pirineos: Revista de Ecologia de Montana PRNOAJ, Vol. 134, p 23-40, 1989. 13 fig, 1 tab, 14 ref.

Descriptors: *Climatology, *Debris cone, *Erosion, *Israel, *Jordan, *Jordan River, *Landslides, *Sediment transport, *Watershed management, Canyons, Clear-cutting, Forest hydrology, Rainfall, Talus.

Extensive active landslides affected by climatic events are found in the Jordan River Gorge. The lithological structure of the basaltic lava flows determine the extent and type of slide; the river removes the talus material promoting further falling and sliding. A total amount of 100,000 cu m of material was removed from the canyon during the January 1969 rainfall event; the average annual debris removal is estimated at 500 cu m/yr. Forest clearing and hydrological changes in the watershed are the main anthropogenic factors promoting erosion processes in the region. (Author's abstract)
W91-03433

DEVELOPMENT AND APPLICATION OF A TECHNIQUE FOR ESTIMATING NUTRIENT DEFICIENCY IN SOFT SEDIMENTS.
Montana State Univ., Bozeman. Dept. of Biology.
For primary bibliographic entry see Field 7B.
W91-03499

FACTORS CONTROLLING SEDIMENT DISCHARGE IN THE MAHANADI RIVER BASIN, INDIA.
Jawaharlal Nehru Univ., New Delhi (India). School of Environmental Sciences.
G. J. Chakrapani, and V. Subramanian.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 169-185, September 1990. 10 fig, 4 tab, 25 ref.

Descriptors: *India, *River sediments, *Sediment discharge, *Sediment load, *Sediments, Geology, Mahanadi River, Monsoons, Rainfall, River basins, River flow, Seasonal variation, Silt load, Suspended sediments.

Annual, seasonal, monthly, and daily variation in the water and sediment discharge in the Mahanadi River and its controlling factors were evaluated. The water discharge varies from 9.61 to 1809.71 cu m/s and the total suspended matter varies from 130 to 806 mg/L. The smaller tributaries upstream carry higher sediment concentration. No yearly cyclic pattern in the water flow in the basin was observed. More than 95% of the sediment discharge takes place in the monsoon, of which the discharge during July, August, and September is 90% of the annual total. On certain days of the year, the sediment discharge accounts for 10-15% of the total annual load. Water discharge, rainfall, and geology of the basin and the smaller tributaries upstream seem to control bulk of the sediment discharge. The Mahanadi annually delivers 15.74 million tonnes of sediment to the Bay of Bengal and more than 80% of the sediment load is carried in the coarse silt fraction. (Author's abstract)
W91-03547

HYDRAULICS OF INTERRILL OVERLAND FLOW ON A SEMI-ARID HILLSLOPE, SOUTHERN ARIZONA.
Keele Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W91-03552

DYNAMICS OF TURBIDITY CURRENTS MEASURED IN KATSURAZAWA RESERVOIR, HOKKAIDO, JAPAN.
Hokkaido Univ., Sapporo (Japan). Dept. of Geophysics.
For primary bibliographic entry see Field 2H.
W91-03555

CONTROLLING SOIL EROSION IN THE ILLINOIS RIVER BASIN.
Illinois Dept. of Agriculture, Springfield. Div. of Natural Resources.
For primary bibliographic entry see Field 4D.
W91-03611

PEORIA LAKE SEDIMENTATION AND PROPOSED ARTIFICIAL ISLANDS.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 5G.
W91-03614

SEDIMENT MANAGEMENT PROBLEMS OF BACKWATER LAKES AND ALTERNATIVE SOLUTIONS.
Illinois State Water Survey Div., Champaign.
N. G. Bhowmik.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 58-64, 4 fig, 1 tab, 11 ref.

Descriptors: *Backwater effect, *Dams, *Environmental effects, *Illinois, *Illinois River, *Locks, *Sedimentation, *Water resources management, Dredging, Flood plains, Lake restoration, Peoria Lake.

The construction of locks and dams along the Illinois River, especially in the reach extending from Grafton to the Lake DePue area, has created a large number of backwater areas within the main floodplains of the river. These backwater areas are called backwater lakes and they are subject to natural variations in water depths and sediment deposition. Over the last 100 years or so all the river basins in Illinois have been subjected to intense human activities and alterations. As a result of these natural and human interventions, the Illinois River Valley has experienced a tremendous amount of sediment deposition in recent years. Many of the 53 or so backwater lakes along this river have lost 30 to 100% of their capacity to sediment deposition. Peoria Lake, a bottomland lake, has lost 68% of its 1903 capacity, and Upper Peoria Lake will eventually attain the appearance of an incised river with broad and shallow wetlands on both sides. On the average, about 20.6 million tons of sediment is deposited annually over the entire valley, with a deposition rate of 0.81 to 2.2 inches per year. Recently implemented nonpoint source pollution control measures are showing their impacts on the receiving bodies of water through substantially lower concentrations of trace elements within the recently deposited sediment. Numerous alternative solutions can be considered for managing these backwater lakes, including constructing closing structures, periodic and selective dredging, using dredged materials to create artificial islands, diverting high flows, imposing management practices on the watershed, and converting some of the backwater lakes to marsh and wetland habitats. A concerted effort, in which various physical, biological and environmental factors are considered, is needed for the development of an acceptable management scenario for these backwater lakes. (See also W91-03608) (Author's abstract)
W91-03615

SEDIMENT MANAGEMENT.
Illinois Univ., Urbana. Water Resources Center.
For primary bibliographic entry see Field 4D.
W91-03627

EROSION CONTROL IN THE ILLINOIS RIVER BASIN PAST, PRESENT, AND FUTURE.
Soil Conservation Service, Champaign, IL.
For primary bibliographic entry see Field 4D.
W91-03630

SUBAERIAL EXPOSURE AND CHANGES IN THE STABILITY OF INTERTIDAL ESTUARINE SEDIMENTS.
Bristol Univ. (England). Dept. of Botany.
For primary bibliographic entry see Field 2L.
W91-03813

DISTRIBUTION AND TEXTURE OF THE BOTTOM SEDIMENTS IN A SEMI-ENCLOSED COASTAL INLET, THE ISMIT BAY FROM THE EASTERN SEA OF MARMARA (TURKEY).
Middle East Technical Univ., Mersin (Turkey). Inst. of Marine Sciences.
For primary bibliographic entry see Field 2L.
W91-03819

FACTORS AFFECTING SULFUR INCORPORATION INTO LAKE SEDIMENTS: PALEOECOLOGICAL IMPLICATIONS.
State Univ. of New York at Syracuse. Coll. of Environmental Science and Forestry.
For primary bibliographic entry see Field 2H.
W91-03828

STABLE ISOTOPIC COMPOSITIONS OF SULFUR IN PIRLA SEDIMENT CORES.
Marine Biological Lab., Woods Hole, MA. Ecosystems Center.
For primary bibliographic entry see Field 2H.
W91-03829

2K. Chemical Processes

GEOCHEMICAL COMPUTER CODES: A REVIEW, FINAL REPORT.
For primary bibliographic entry see Field 7C.
W91-03027

STEAM DISTILLATION WITH RESIN EXTRACTION FOR ISOLATION AND CONCENTRATION OF ORGANIC COMPOUNDS FROM AQUEOUS SAMPLES.
Ames Lab., IA.
K. D. Dix, and J. S. Fritz.
Analytica Chimica Acta ACACAM, Vol. 236, No. 1, p 43-49, September 1990. 3 fig, 6 tab, 31 ref. U.S. Department of Energy Contract W-7405-Eng-82.

Descriptors: *Analytical methods, *Distillation, *Organic compounds, *Separation techniques, *Water analysis, Chemical analysis, Ethyl acetate, Gas chromatography, Pollutant identification, Resins.

Steam distillation was combined with solid-phase resin extraction using a simple apparatus and interface for the isolation and concentration of organic compounds from aqueous samples. Ethyl acetate was efficient for the removal of all analytes tested. Factors affecting the recovery of model compounds were the cleanliness of the glassware and sticking of compounds to the condenser. The recovery of methyl esters and many other compounds was markedly improved by disconnecting the condenser. Recoveries of 80% or better were obtained for a wide variety of organic compounds with boiling points ranging from 136 to 404 C with a run time of less than 25 minutes. A concentration effect of at least 100-fold allowed the analysis of compounds at the microgram/L range using gas chromatography with flame ionization detection. (Geiger-PTT)
W91-03290

SOLID-PHASE EXTRACTION OF HERBICIDES FROM WELL WATER FOR DETERMINATION BY GAS CHROMATOGRAPHY-MASS SPECTROMETRY.
Monsanto Agricultural Products Co., St. Louis, MO.
For primary bibliographic entry see Field 5A.
W91-03292

GEOCHEMISTRY OF SHALLOW GROUNDWATER AT KIGAMBONI PENINSULA ALONG DAR ES SALAAM COASTAL STRIP TANZANIA.
Dar es Salaam Univ. (Tanzania). Dept. of Geography.
For primary bibliographic entry see Field 2F.
W91-03337

DIGITAL MODELLING OF THE HYDROGEOCHEMICAL FACIES OF GROUNDWATERS IN TAMILNADU, INDIA.
V.O.C. Coll., Tuticorin (India). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W91-03339

HYDROCHEMICAL CLASSIFICATION OF THE GROUNDWATER OF THE WADI AL BIH WELLFIELD IN THE NORTHERN PART OF THE UNITED ARAB EMIRATES.
United Arab Emirates Univ., Al Ain. Dept. of Geology
F. El Schami, and A. R. Hamdan.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 853-865, 7 fig, 2 tab, 9 ref.

Descriptors: *Geochemistry, *Groundwater quality, *Salinity, *United Arab Emirates, *Water quality, Aquifer characteristics, Classification, Groundwater chemistry, Regional analysis, Saline groundwater, Spatial distribution, Well fields.

The Wadi al Bih well field is considered one of the most important fresh water well fields in the

United Arab Emirates. Examination of the hydrochemistry of the groundwater shows the variability in areal distribution of the major groundwater chemistry types and the change in groundwater quality with time. Nine major groundwater types have been identified and delineated using the numerical approach to classification derived by Haddad. The overall chemistry of the Wadi al Bih groundwater indicates that alkalies exceed alkaline earths and strong acids exceed weak acids. The salinity of the production water wells ranged from 360 to 3670 mg/L in 1987 and from 435 to 4,140 mg/L in 1988. The fresh groundwater is concentrated around the periphery of the well field, whereas most of the salinity is found in the central portion. (See also W91-03311) (Rochester-PTT)
W91-03347

HYDROGEOCHEMICAL MODELING.
Kerala Univ., Trivandrum (India). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W91-03352

DISTRIBUTION OF FLUORIDE IN SHALLOW AQUIFERS IN AND AROUND DISTRICT ROHTAK, HARYANA STATE.
Panjab Univ., Chandigarh (India). Dept. of Geology.
S. Kumar, and A. Syed.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 911-915, 1 fig, 1 tab, 9 ref.

Descriptors: *Agricultural chemicals, *Fertilizers, *Fluorides, *Geochemistry, *Groundwater pollution, *India, *Nonpoint pollution sources, *Water pollution sources, Aquifers, Drinking water, Fluorapatite, Groundwater chemistry, Human diseases, Phosphates, Public health.

Fluoride concentration in the range 0.6-1.2 mg/L is essential in potable water for substantial protection against dental caries, but higher concentrations can cause mottling of the teeth and even higher concentrations may lead to fluorosis. Geochemical factors affecting the occurrence and distribution of fluoride were examined with respect to shallower aquifers in and around Rohtak, Haryana, India. The analytical results reveal that high fluoride concentration is a major problem in the area studied. Fluoride concentration exceeding the desirable limit (0.6-1.2 mg/l) is a major health hazard. Fourteen samples had concentrations within the desirable range, but five samples had a value below 0.6 mg/L. Most of the area had fluoride concentrations above 1.2 mg/L, with some areas having values >2 mg/L (highest value = 4.10 mg/L). High values can be attributed to the use of phosphatic fertilizers and the presence of fluor-apatite, which are being leached down to the saturated zone in irrigation return flows. (See also W91-03311) (Author's abstract)
W91-03354

RADON, RADIUM AND URANIUM IN DRINKING WATER.
For primary bibliographic entry see Field 5F.
W91-03366

OCCURRENCE OF RADIONUCLIDES IN DRINKING WATER, A NATIONAL STUDY.
Environmental Protection Agency, Cincinnati, OH. Office of Administration and Resources Management.
For primary bibliographic entry see Field 5B.
W91-03373

HIGH-PERFORMANCE LIQUID CHROMATOGRAPHIC APPROACH FOR MONITORING ETHOFUMESATE IN PLANT, SOIL AND WATER.
Jordan Univ., Amman. Analytical Chemistry Labs.
For primary bibliographic entry see Field 5A.
W91-03412

PRECIPITATION CHEMISTRY: ATMOSPHERIC LOADINGS TO THE SURFACE WATERS OF THE INDIAN RIVER LAGOON BASIN BY RAINFALL.
Bionetics Corp., Cocoa Beach, FL.
T. W. Dreschel, B. C. Madsen, L. A. Maull, C. R. Hinkle, and W. M. Knott.
Florida Scientist FLSCAQ, Vol. 53, No. 3, p 184-188, Summer 1990. 1 fig, 2 tab, 13 ref.

Descriptors: *Acid rain, *Chemistry of precipitation, *Deposition, *Florida, *Indian River Lagoon, *Nutrients, *Water pollution sources, *Wet deposition, Ammonium, Baseline studies, Limiting nutrients, Nitrates, Seasalt, Sulfates, Surface runoff, Surface water, Wastewater pollution.

Rain volume and chemistry monitoring as part of the Kennedy Space Center Long Term Environmental Monitoring Program included the years 1984-1987 as part of the National Atmospheric Deposition Program. Atmospheric deposition in rainfall consisted primarily of seasalt and hydrogen ion, sulfate, nitrate, and ammonium ions. The deposition of nitrogen (a principal plant nutrient) was on the order of 200-300 metric tons per year to the surface waters. Although the contribution of rainfall to the total nitrogen budget is smaller than that of other sources, it was about one-third of that contributed by sewage effluent in 1985. It can be construed as the current background level of nitrogen input. Phosphorus, which is not a significant constituent of rainfall, is probably the primary limiting nutrient of the lagoon system. This information indicates that control of nutrient loading from surface runoff and domestic effluent is essential to reducing the nutrient enrichment of the Indian River lagoon basin. (MacKee:-PTT)
W91-03440

FIELD METHODS FOR MEASUREMENT OF GROUND WATER REDOX CHEMICAL PARAMETERS.
Geological Survey, Denver, CO. Geologic Div.
For primary bibliographic entry see Field 7B.
W91-03444

NITROGEN METABOLISM IN THE BRACKISH LAKE NAKANOUMI: IV. SEASONAL VARIATION OF NITRATE NITROGEN.
Shimane Univ., Matsue (Japan). Environmental Science Lab.
For primary bibliographic entry see Field 2H.
W91-03452

SIGNIFICANCE OF LOW-OXYGEN ZONE FOR NITROGEN CYCLING IN A FRESHWATER LAKE: PRODUCTION OF N2O BY SIMULTANEOUS DENITRIFICATION AND NITRIFICATION.
Nagoya Univ. (Japan). Water Research Inst.
For primary bibliographic entry see Field 2H.
W91-03453

RELATIONSHIPS BETWEEN PHYTOPLANKTON OCCURRENCE AND SALINITY OR WATER TEMPERATURE IN BRACKISH LAKE NAKANOUMI, 1979-1986.
Shimane Univ., Matsue (Japan). Environmental Science Lab.
For primary bibliographic entry see Field 2H.
W91-03455

DETERMINATION OF TOTAL PHOSPHORUS IN WATERS WITH AMPEROMETRIC DETECTION BY COUPLING OF FLOW-INJECTION ANALYSIS WITH CONTINUOUS MICROWAVE OVEN DIGESTION.
Technische Univ. Clausthal, Clausthal-Zellerfeld (Germany, F.R.). Anorganisch-Chemisches Inst.
For primary bibliographic entry see Field 5A.
W91-03458

FIELD METHOD FOR DETERMINATION OF TRACES OF THIOLS IN NATURAL WATERS.
Rosenstiel School of Marine and Atmospheric Science, Miami, FL. Div. of Marine and Atmospheric Chemistry.
For primary bibliographic entry see Field 5A.
W91-03459

CRITICAL COMPARISON OF TWO STANDARD DIGESTION PROCEDURES FOR THE DETERMINATION OF TOTAL MERCURY IN NATURAL WATER SAMPLES BY COLD VAPOUR ATOMIC ABSORPTION SPECTROMETRY.
Umea Univ. (Sweden). Dept. of Analytical Chemistry.
For primary bibliographic entry see Field 5A.
W91-03460

PRECONCENTRATION OF LEAD, CADMIUM, COPPER AND ZINC IN WATER AT THE G/G LEVEL BY NON-BOILING EVAPORATION.
Laboratoire de Glaciologie et Geophysique de l'Environnement, Saint-Martin d'Heres (France).
For primary bibliographic entry see Field 5A.
W91-03461

DETERMINATION OF VANADIUM IN WATER BY ATOMIC ABSORPTION SPECTROMETRY WITH ELECTROTHERMAL ATOMIZATION AND USING HOT INJECTION AND PRECONCENTRATION ON THE GRAPHITE TUBE.
Santiago Univ. (Spain). Faculty of Chemistry.
For primary bibliographic entry see Field 5A.
W91-03462

DETERMINATION OF GOLD IN NATURAL WATERS BY NEUTRON ACTIVATION AND GAMMA-SPECTROMETRY AFTER PRECONCENTRATION WITH TRIBUTYL PHOSPHATE AS SOLID EXTRACTANT.
Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions.
T. V. Shishkina, S. N. Dmitriev, and S. V. Shishkin.
Analytica Chimica Acta ACACAM, Vol. 236, No. 2, p 483-486, September 17, 1990. 1 tab, 23 ref.

Descriptors: *Analytical techniques, *Chemical analysis, *Gold, *Laboratory techniques, *Spectrometry, *Water analysis, Analytical methods, Charcoal, Gamma radiation, Neutron activation analysis, Tributyl phosphate.

A method for the preconcentration of gold in natural waters at the sampling site using tributyl phosphate as a solid extractant was developed as a preliminary step prior to the determination of gold by neutron activation and gamma-spectrometry. The tributyl phosphate was saturated with gaseous chlorine for extracting all gold species. In batch experiments gold was quantitatively retained on the tributyl phosphate in 10 minutes. After extraction and washing, the tributyl phosphate was ashed or back-extracted. Gold was quantitatively eluted with hot, neutral 0.025 molar thiourea. The gold content of residues of ashing or eluents after evaporation was determined by neutron activation and gamma-spectrometry. The detection limit for the overall procedure was 0.2 nanogram/L. The efficiency was tested on equilibrated solutions prepared from river water and tracer solutions of gold. Twenty samples of equilibrated gold solution were prepared as indicated and preconcentration with the solid extractant was carried out after 20 days. The results of counting were compared with those for standard concentrated solutions prepared simultaneously with equilibrated gold solutions from aliquots of a gold solution containing 195-Au tracer. In was found that 98% +/-2% of gold was adsorbed on tributyl phosphate. The efficiency of the proposed method was confirmed by the simultaneous use of the activated charcoal preconcentration technique. Comparison of the results indicates that the use of the chlorine-saturated solid extractant containing about 45% tributyl phosphate for the concentration of gold from natural waters was very efficient. (Mertz-PTT)
W91-03463

NITRATE DEPLETION IN THE RIPARIAN ZONE AND STREAM CHANNEL OF A SMALL HEADWATER CATCHMENT.
Department of Scientific and Industrial Research, Hamilton (New Zealand). Water Quality Centre.
For primary bibliographic entry see Field 5B.
W91-03483

DOWNSTREAM EFFECTS OF IMPOUNDMENTS ON THE WATER CHEMISTRY OF THE BUFFALO RIVER (EASTERN CAPE), SOUTH AFRICA.
Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
For primary bibliographic entry see Field 2H.
W91-03485

EVOLUTION OF THE CHEMICAL COMPOSITION OF WATER PASSING THROUGH THE UNSATURATED ZONE TO GROUND WATER AT AN EXPERIMENTAL SITE AT THE UNIVERSITY OF SAO PAULO, BRAZIL.
Sao Paulo Univ. (Brazil). Inst. de Geociencias.
For primary bibliographic entry see Field 2F.
W91-03747

CL-36 IN GROUND WATER OF THE MAZOWSZE BASIN (POLAND).
Polish Academy of Sciences, Warsaw. Geological Sciences Inst.
J. Dowgiallo, Z. Nowicki, J. Beer, G. Bonani, and M. Suter.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 373-385, October 1990. 4 fig, 1 tab, 23 ref.

Descriptors: *Chlorine radioisotopes, *Environmental tracers, *Geochemistry, *Geohydrology, *Groundwater movement, *Poland, *Radioactive tracers, *Tracers, Confined aquifers, Geologic fractures, Groundwater recharge, Hydraulic properties, Precipitation, Water chemistry.

Groundwater samples from the Oligocene aquifer of the Mazowsze artesian basin in Poland have been analyzed for Cl-36 using the ETH/PSI-AMS facility. The results show that: (1) the measured Cl-36/Cl ratios for samples taken in the recharge areas of the basin are in good agreement with calculations based on assumption of Cl-36 fallout in modern precipitation; (2) some of the samples show a reduced Cl-36/Cl ratio as compared with the assumed input value and the corresponding points on the dilution curve, presumably representative for the whole area, pointing to radioactive decay as the main process responsible for the decrease of Cl-36 content in water; and (3) several samples show an increase in Cl-36 concentration as compared with the input value corrected for dilution. As the neutron flux in Oligocene deposits is supposed to be low, there must be inflow of water from formations underlying the aquifer. Hydraulic connections of the Lower Triassic formation with the Oligocene deposits are possibly a result of tectonic movements which produced fissure systems. This study is preliminary, and further investigations should concentrate on the evaluation of Cl-36 production in the Oligocene and the underlying formations. Since the interpretation of Cl-36 measurements depends strongly on the recharge values, more detailed data regarding the Cl-36 content of water penetrating into the aquifer are needed. The results obtained so far show that the application of Cl-36 as a hydrogeological tracer is useful, although the interpretation of these results can be difficult. (Fish-PTT)
W91-03759

NEAR-SHORE HYPOXIA IN THE CHESAPEAKE BAY: PATTERNS AND RELATIONSHIPS AMONG PHYSICAL FACTORS.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 2L.
W91-03816

TRACE METAL CHEMISTRY OF A DUTCH RESERVOIR, THE TJEUKEMEER.
Limnologisch Inst., Oosterzee (Netherlands). Tjeukemeer Lab.
For primary bibliographic entry see Field 2H.
W91-03827

DISSOLVED FREE AMINO ACID CYCLING IN AN ESTUARINE OUTFLOW PLUME.
University of Southern California, Los Angeles. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2L.
W91-03836

SPECTROPHOTOMETRIC DETERMINATION OF ANIONIC SURFACTANTS IN TAP AND RIVER WATERS WITH 1-(10-BROMODECYL)-4-(4-AMINONAPHTHYLAZO)-PYRIMIDINIUM BROMIDE.
Okayama Univ. (Japan). School of Health Sciences.
For primary bibliographic entry see Field 5A.
W91-03839

GAS CHROMATOGRAPHIC DETERMINATION OF SYSTEMIC FUNGICIDE TRICYCLAZOLE IN SOIL AND WATER.
Zhejiang Agricultural Univ., Hangzhou (China). Dept. of Plant Protection.
For primary bibliographic entry see Field 5A.
W91-03846

STRUCTURAL AND STRATIGRAPHIC FRAMEWORK OF GROUNDWATER OCCURRENCE AND SURFACE DISCHARGE IN THE MURRAY BASIN, SOUTHEASTERN AUSTRALIA.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
For primary bibliographic entry see Field 2F.
W91-03889

HYDROGEOLOGY OF THE MURRAY BASIN, SOUTHEASTERN AUSTRALIA.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
For primary bibliographic entry see Field 2F.
W91-03890

SALINE SEEPAGE AND LAND DEGRADATION--A NEW SOUTH WALES PERSPECTIVE.
Soil Conservation Service of New South Wales, Sydney (Australia).
For primary bibliographic entry see Field 5B.
W91-03893

EFFECT OF LAND CLEARANCE IN THE MALLEE REGION ON RIVER MURRAY SALINITY AND LAND SALINISATION.
South Australian Dept. of Mines and Energy, Adelaide.
For primary bibliographic entry see Field 4C.
W91-03894

ASPECTS OF STRATIGRAPHY AND STRUCTURE IN RELATION TO THE WOOLPUNDA GROUNDWATER INTERCEPTION SCHEME, MURRAY BASIN, SOUTH AUSTRALIA.
South Australian Dept. of Mines and Energy, Adelaide.
For primary bibliographic entry see Field 2F.
W91-03896

GROUNDWATER-RIVERWATER DENSITY CONTRAST: ITS EFFECT ON THE PATTERN OF GROUNDWATER DISCHARGE TO THE RIVER MURRAY.
South Australian Dept. of Engineering and Water Supply, Adelaide.
For primary bibliographic entry see Field 2F.
W91-03897

ENVIRONMENTAL CONSEQUENCES OF SALINE GROUNDWATER INTRUSION INTO THE WIMMERA RIVER, VICTORIA.
Kaiela Fisheries Research Station, Shepparton (Australia). Fisheries Div.
For primary bibliographic entry see Field 2F.
W91-03898

TATIARA PROCLAIMED REGION, SOUTHEASTERN SOUTH AUSTRALIA: HYDROGEOLOGICAL INVESTIGATIONS AND GROUNDWATER MANAGEMENT.
South Australian Dept. of Mines and Energy, Adelaide.
For primary bibliographic entry see Field 4B.
W91-03899

CHLORINE-36 MEASUREMENTS IN THE MURRAY BASIN: PRELIMINARY RESULTS FROM THE VICTORIAN AND SOUTH AUSTRALIAN MALLEE REGION.
Australian Nuclear Science and Technology Organisation, Sutherland.
For primary bibliographic entry see Field 2F.
W91-03900

ORIGINS OF GROUNDWATER SALINITY NEAR TRESCO, NORTHWEST VICTORIA.
New South Wales Univ., Kensington (Australia). Centre for Groundwater Management and Hydrogeology.
For primary bibliographic entry see Field 2F.
W91-03902

IVANHOE BLOCK--ITS STRUCTURE, HYDROGEOLOGY AND EFFECT ON GROUNDWATERS OF THE RIVERINE PLAIN OF NEW SOUTH WALES.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
For primary bibliographic entry see Field 2F.
W91-03905

GEOLOGICALLY INDUCED SALINITY AT YELARBON, BORDER RIVERS AREA, NEW SOUTH WALES, QUEENSLAND.
New South Wales Univ., Kensington (Australia). Centre for Groundwater Management and Hydrogeology.
For primary bibliographic entry see Field 2F.
W91-03906

APPLICATION OF LANDSAT THEMATIC MAPPING TO GEOLOGY AND SALINITY IN THE MURRAY BASIN.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
For primary bibliographic entry see Field 7B.
W91-03907

STRATIGRAPHY AND SEDIMENTOLOGY OF MID-TERTIARY PERMEABILITY BARRIERS IN THE SUBSURFACE OF THE MURRAY BASIN, SOUTHEASTERN AUSTRALIA.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
For primary bibliographic entry see Field 2F.
W91-03908

FIELD EVIDENCE FOR THE EFFECT OF ACETATE ON LEACHATE ALKALINITY.
Water and Earth Science Associates Ltd., Kitchener (Ontario).
For primary bibliographic entry see Field 5B.
W91-03910

2L. Estuaries

SAN FRANCISCO CENTRAL BAY SUSPENDED SEDIMENT MOVEMENT. REPORT 1: SUMMER CONDITION DATA COLLECTION PROGRAM AND NUMERICAL MODEL VERIFICATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 2J.
W91-03010

SUWANNEE RIVER ESTUARY: AN OVERVIEW AND RESEARCH AND MANAGEMENT NEEDS.
Suwannee River Water Management District, Live Oak, FL.
For primary bibliographic entry see Field 2H.
W91-03094

DEVELOPMENT OF MANAGEMENT STRATEGIES FOR BARATARIA BASIN, LOUISIANA.
Louisiana Geological Survey, Baton Rouge.
For primary bibliographic entry see Field 5G.
W91-03095

WETLAND CREATION AND RESTORATION: THE STATUS OF THE SCIENCE.
Island Press, Covelo, California. 1990. 594p. Edited by Jon A. Kusler, and Mary E. Kentula.

Descriptors: *Artificial wetlands, *Habitat restoration, *Management planning, *Publications, *Water resources management, *Wetland restoration, *Wetlands, Compensation, Decision making, Environmental control, Environmental engineering, Environmental impact, Environmental protection, Regional planning, Research priorities, United States, Water law, Water resources development.

In the last decade, interest has increased in coastal and freshwater wetland restoration and creation at all levels of government, in the scientific community, and in the private sector. Restoration and creation have been advocated to reduce the impacts of wetlands activities; compensate for additional losses; restore or replace wetlands already degraded or destroyed; and serve various new functions such as wastewater treatment, aquaculture, and waterfowl habitat. U.S. Environmental Protection Agency personnel agreed that there was a pressing need to determine how well created and restored wetlands compensate for losses permitted under Section 404 of the Clean Water Act. An effort was made to capture information not published elsewhere and incorporate it with published literature to produce a unique resource. The status report is the first major publication resulting from research initiated on wetland creation and restoration. Conceived as a mechanism for identifying the adequacy of the available information, this status report will help set priorities for the research program and provide Agency personnel with an analytical framework for making Section 404 permit decisions based on the status of the science of wetland creation and restoration. The report is composed of two volumes. The first volume is a series of regional reviews, summarizing wetland creation and restoration experiences in broadly-defined wetland 'regions.' the second volume is a series of theme papers, covering a wide range of topics of general application to wetland creation and restoration (hydrology, management techniques, planning). (See W91-03245 thru W91-03272) (Fish-PTT)
W91-03244

WETLAND MITIGATION ALONG THE PACIFIC COAST OF THE UNITED STATES.
San Francisco State Univ., Tiburon, CA. Tiburon Center for Environmental Studies.
M. Josselyn, J. Zedler, and T. Griswold.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 3-36, 1 fig, 6 tab, 74 ref, 2 append.

Descriptors: *Artificial wetlands, *Coastal zone management, *Habitat restoration, *Water resources management, *Wetland restoration, *Wetlands, Coastal lagoons, Coastal marshes, Databases, Estuarine environment, Hydrologic properties, Monitoring, Vegetation establishment, Water resources development, Watershed management, Wildlife habitats.

Mitigation to compensate for coastal wetland losses has taken place under federal and state permit policies for over 15 years. As a result, a substantial database has developed in the scientific and governmental literature on which to base recommendations for improvement in mitigation practice. Hydrologic characteristics of a mitigation site are especially important as they structure the possible wetland habitats that can be created. Within the Pacific coastal zone, four general hydrological types occur: wetlands associated with small rivers or lagoons, wetlands associated with major estuaries and coastal embayments, wetlands associated with rivers, and non-tidal wetlands. Within each of these broad categories, watershed management and specific opportunities and constraints must be considered prior to approving mitigation proposals. Elements that need to be included within mitigation proposals are a description of existing conditions, a description of proposed hydrological conditions, means by which mitigation site constraints are to be ameliorated, planting procedures, determination of appropriate buffers, enforceable construction procedures, and monitoring programs. Outside of site-specific review, resource agencies must assess the long-term implications of individual permit approvals. Reappraisal should be based on detailed analysis contained within accessible database files. Such appraisal can provide important information on regional trends and means by which mitigation can be redirected to better serve fish and wildlife needs. (See also W91-03244) (Author's abstract)
W91-03245

CREATION AND RESTORATION OF TIDAL WETLANDS OF THE SOUTHEASTERN UNITED STATES.
North Carolina State Univ., Raleigh. Dept. of Soil Science.
S. W. Broome.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 37-72, 10 fig, 4 tab, 85 ref.

Descriptors: *Artificial wetlands, *Habitat restoration, *Tidal marshes, *Water resources management, *Wetland restoration, *Wetlands, Economic aspects, Environmental engineering, Management planning, Marsh management, Soil properties, Tidal effects, Water resources development.

Methods of creation and restoration of tidal wetlands in the southeastern United States have been summarized from published papers, reports, and first-hand experience. Publications by the U.S. Army Corps of Engineers which report research related to marsh habitat creation with dredged material and for shoreline erosion control were significant sources of information. Critical aspects which should be considered in planning and implementing a tidal marsh creation or restoration project are: initial planning, elevation in relation to tide level, wave climate and currents, salinity, slope and tidal range, soil chemical and physical properties, timing of construction, cultural practices, and maintenance. Critical research needs include: site selection, revegetation, and documentation of tidal marsh development. Practical and economical methods are needed to evaluate success of individual marsh creation or restoration. (See also W91-03244) (Author's abstract)
W91-03246

CREATION AND RESTORATION OF COASTAL PLAIN WETLANDS IN FLORIDA.
Lewis Environmental Service, Inc., Tampa, FL.
R. R. Lewis.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 73-101, 9 fig, 75 ref, 3 append. U.S. Department of Commerce Office of Sea Grant grant R/C-E-24.

Descriptors: *Artificial wetlands, *Florida, *Tidal marshes, *Water resources management, *Wetland restoration, *Wetlands, Drainage engineering, Environmental impact, Habitat restoration, Mangrove swamps, Plant populations, Planting management, Tidal effects, Vegetation establishment, Water resources development.

Despite hundreds of mangrove and tidal marsh restoration and creation efforts in Florida over the last fifteen years, current efforts are largely more art than science. Adequate monitoring and reporting are rare, and no institutional memory exists to improve the review and monitoring process. An overview of the Floridian region is given, followed by discussions of the extent to which creation/restoration has occurred, the design of creation/restoration projects, monitoring, and information gaps and research needs. Appendices include recommended reading, a list of project profiles, and a permit review checklist for Florida coastal wetlands. Based on a critical review of actual projects and the sparse literature, five factors appear most important to successful wetland establishment; these are: (1) correct elevations for the target plant species; (2) adequate drainage provided by gradual slopes and sufficient tidal connections; (3) appropriate site selection to avoid wave damage; (4) appropriate plant materials; and (5) protection from human impacts. (See also W91-03244) (Fish-PTT)
W91-03247

CREATION AND RESTORATION OF COASTAL WETLANDS IN PUERTO RICO AND THE U.S. VIRGIN ISLANDS.
Lewis Environmental Service, Inc., Tampa, FL.
R. R. Lewis.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 103-123, 10 fig, 37 ref, 3 append.

Descriptors: *Artificial wetlands, *Puerto Rico, *Virgin Islands (US), *Water resources management, *Wetland restoration, *Wetlands, Habitat restoration, Mangrove swamps, Plant growth, Planting management, Research priorities, Vegetation establishment, Water resources development.

Major losses of coastal wetland habitat in Puerto Rico and the U.S. Virgin Islands have stimulated interest in restoring damaged areas, and in requiring mitigation in the form of wetlands creation or restoration for any future permitted losses. Unlike efforts on the mainland, documentation of efforts to date is sparse. The major emphasis to date has been on mangrove forests, but other wetland types are equally important. Observations indicate that the opening of impounded mangrove areas works well as restoration, but creation of mangrove areas is more difficult because of the need to very carefully control the final graded elevations. The optimum target elevation for mangrove establishment appears to be +12 cm National Geodetic Vertical Datum. Wetland restoration projects in the U.S. Virgin Islands and Puerto Rico need more centralized documentation in order to capitalize on the advances in understanding that come with each project. Some additional experimental work is also essential to determine the restoration potential of plant communities in which research has not yet been undertaken. (See also W91-03244) (Author's abstract)
W91-03248

CREATION, RESTORATION, AND ENHANCEMENT OF MARSHES OF THE NORTHCENTRAL GULF COAST.
Louisiana State Univ., Baton Rouge. School of Forestry, Wildlife and Fisheries.
For primary bibliographic entry see Field 2H.
W91-03249

CREATION AND RESTORATION OF COASTAL WETLANDS OF THE NORTHEASTERN UNITED STATES.
J. K. Shisler.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 143-170, 8 fig, 1 tab, 83 ref, 2 append.

Descriptors: *Artificial wetlands, *Coastal zone management, *Habitat restoration, *Water resources management, *Wetland restoration, *Wetlands, Monitoring, Performance evaluation, Vegetation establishment, Water resources development, Watershed management.

The wetlands of the coastal zone of the northeast have been managed since the colonization of the United States. Restoration work associated with mitigation of impacts has been going on in the

region for over twenty years. Despite this history, there has not been an extensive evaluation of these projects to determine their success and how they function. The mitigation process should be directed towards a management approach that is concerned with the total system instead of just the 'vegetated' wetland. Goals should be based upon a wetland system's requirements within a watershed or region. The use of adjacent wetlands as models is critical in this process. Monitoring the created or restored wetlands can provide an important database which can be used in planning future projects. Goals, clearly defined in the design process, will promote meaningful evaluations. (See also W91-03244) (Author's abstract)
W91-03250

REGIONAL ANALYSIS OF THE CREATION AND RESTORATION OF SEAGRASS SYSTEMS.
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
M. S. Fonseca.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 171-193, 1 fig, 2 tab, 55 ref, 2 append.

Descriptors: *Aquatic habitats, *Artificial wetlands, *Sea grasses, *Water resources management, *Wetland restoration, *Wetlands, Coastal zone management, Environmental impact, Habitat restoration, Monitoring, Plant growth, Planting management, Research priorities, Vegetation establishment, Water resources development.

Seagrasses occur in most coastal marine regions and are highly productive habitats. They are not a traditional wetland type but do meet the criteria for protection of aquatic habitat under Section 404 of the Clean Water Act. Goals and performance guidelines for seagrass restoration and creation projects should include: development of persistent cover, generation of equivalent acreage or increased acreage, replacement with the same seagrass species, and restoration of secondary (faunal) production. These goals are to be differentiated from measures of density and percent survival. Monitoring for cover and persistence should continue for 3 years. The primary choice for restoration sites should be areas previously impacted or lost. The secondary choices should be perturbed aquatic areas or uplands which can be excavated and converted to seagrass habitat. Population growth rate determines the species chosen. Research needs include: defining functional restoration, compiling population growth and coverage rates by ecoregion, examining the resource role of mixed species plantings, determining the impact of substituting pioneer for climax species on faunal composition and abundance, evaluating the substitution of other species on cumulative damage to habitat resources when suitable sites cannot be found for seagrass planting, developing culture techniques for propagule development, exploring transplant optimization techniques, and delineating seagrass habitat boundaries. Most important would be the implementation of a consistent policy on seagrass restoration and management among resource agencies wherein restoration technique, monitoring, and performance and compliance guidelines would be standardized. (See also W91-03244) (Author's abstract)
W91-03251

OVERVIEW AND FUTURE DIRECTIONS.
San Diego State Univ., CA. Pacific Estuarine Research Lab.
For primary bibliographic entry see Field 2H.
W91-03260

INFORMATION NEEDS IN THE PLANNING PROCESS FOR WETLAND CREATION AND RESTORATION.
E. W. Garbisch.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 423-427.

Descriptors: *Administrative regulations, *Artificial wetlands, *Management planning, *Water resources management, *Wetland restoration, *Wetlands, Administrative agencies, Data requirements, Project planning, Water law, Water resources development.

State wetland regulations and policies vary widely and many are still under development. Marked variances also occur in the administration of federal regulations in the east and probably nationwide. Consequently, it is not possible to recommend a planning process for wetland creation and restoration that will be uniformly acceptable. However, there are both factors which should be considered at various stages of the permitting process and those which should be contained in plans to create or restore wetlands. Wetland regulatory agencies need to critically evaluate proposed mitigation projects in terms of acceptability, feasibility, and soundness. The permit conditions should contain (1) details of construction and landscape plans, (2) specifications to facilitate verification by the regulatory agencies that the wetland creation/restoration project has been constructed according to the plans, and (3) the criteria by which to determine if the project has been maintained and monitored during the life of the permit. To a very large degree, the success of wetland creation/restoration projects will depend on the correctness of the plans and specifications and the execution of the construction according to these plans and specifications. To ensure that future wetland creation/restoration projects are planned and directed by qualified people, it is suggested that preliminary, draft, and final mitigation plans be approved by an individual who has been certified as a qualified wetland creation/restoration scientist. (See also W91-03244) (Fish-PTT)
W91-03262

WETLAND EVALUATION FOR RESTORATION AND CREATION.
Erwin (Kevin L.) Consulting Ecologist, Inc., Fort Myers, FL.
K. L. Erwin.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 429-458, 4 fig, 2 tab, 39 ref, append.

Descriptors: *Artificial wetlands, *Management planning, *Performance evaluation, *Project planning, *Water resources management, *Wetland restoration, *Wetlands, Administrative agencies, Decision making, Environmental policy, Evaluation, Water resources development.

Evaluation of the success of a created, restored, or enhanced wetland must be addressed in terms of the extent to which the wetland provides biological and hydrological functions similar to those of the original or desired 'reference' wetland. The selected evaluation method must adequately characterize and evaluate the functions of the created and reference wetlands given the limitations of time, budget, type of wetland, size of wetland, context, degree of alteration from original wetland, location, and expertise of investigator. A qualitative wetland evaluation plan should include: a baseline vegetation survey, annual reporting of post-construction monitoring, fixed-point panoramic photographs, rainfall and water level data, a plan view showing all sampling and recording stations, wildlife utilization observations, fish and macroinvertebrate data, a maintenance plan, and a qualified individual to conduct monitoring. Quantitative evaluation should include: surface and groundwater hydrological monitoring, and vegetation analysis. A rapidly-accessible, easily understood, and cost-effective database on wetland creation and restoration projects is needed to support environmental regulatory agency review, decision-making, and action on specific projects. Any comprehensive wetland evaluation effort must be proceeded by the establishment of criteria which the investigator and regulator believe to be fundamental to the existence, functions, and contributions of the wetland system and its surrounding landscape. Additional research is needed to establish the interrelationships between wetlands, transitional areas, and adjacent uplands. (See also W91-03244) (Author's abstract)
W91-03263

WETLAND DYNAMICS: CONSIDERATIONS FOR RESTORED AND CREATED WETLANDS.
Indiana Univ. at Bloomington. School of Public and Environmental Affairs.
D. E. Willard, and A. K. Hiller.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 459-466, 19 ref.

Descriptors: *Artificial wetlands, *Management planning, *Project planning, *Water resources management, *Wetland restoration, *Wetlands, Alternative planning, Emergency planning, Environmental impact statement, Uncertainty, Water resources development.

Wetlands are affected by intrinsic and extrinsic forces. Managers cannot always predict or control the extrinsic forces leading to wetland changes, nor can they predict the range of species adaptations to those changes. Managers should plan for extreme circumstances by including mechanisms for wetland adjustment and persistence and by maintaining multiple sites as refugia to spread the risk of catastrophe. The following considerations are recommended: creation of buffer zones and corridors; recreation of spatial and temporal habitat variability; maintaining marginal wetlands as reserve sites; planning for worst case scenarios (cumulative impacts); and management for uncertainty and risk in wetland restoration and creation. Unfortunately, the natural variability of ecosystems, the unpredictability of extrinsic forces, and the perversity of complex systems make any absolute guarantee of success impossible. (See also W91-03244) (Author's abstract)
W91-03264

WATERFOWL MANAGEMENT TECHNIQUES FOR WETLAND ENHANCEMENT, RESTORATION AND CREATION USEFUL IN MITIGATION PROCEDURES.
Texas A and M Univ., College Station. Dept. of Wildlife and Fisheries Sciences.
M. W. Weller.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 517-528, 87 ref.

Descriptors: *Artificial wetlands, *Water resources management, *Waterfowl, *Wetland restoration, *Wetlands, *Wildlife habitats, Aquatic weed control, Ecosystems, Environmental management, Habitat restoration, Water resources development.

Waterfowl and other wetland wildlife managers have long been involved in wetland restoration and enhancement, and have developed functional techniques for management of certain wetland types in various regions. These procedures can serve other wetland managers in many useful ways, and are worthy of experimentation for other purposes. Most use natural processes to tap natural seed banks, modify cover-water ratios, or control weeds via water level control and herbivores. Wetland types where procedures have been standardized include those dominated by palustrine persistent emergents, moist-soil nonpersistent emergents, estuarine emergents, and forested palustrine communities. These strategies may be adapted to the special situations of restoring, enhancing or creating wetlands to meet mitigation requirements. The procedures also can be used to enhance various wetland functions such as water quality, shoreline protection, and esthetic values. Major information gaps include: long-term ecological effects of management processes; methods for speeding natural events that aid in wetland restoration; and lack of quantitative information on other groups of wildlife such as fish, herptiles, and even nongame birds and mammals. (See also W91-03244) (Author's abstract)
W91-03269

NUTRIENT DYNAMICS ASSOCIATED WITH LEAF DECOMPOSITION IN A SMALL SUBTROPICAL MANGROVE COMMUNITY IN HONG KONG.
Hong Kong Polytechnic, Kowloon. Dept. of Ap-

plied Biology and Chemical Technology.
N. F. Y. Tam, L. L. P. Vrijmoed, and Y. S. Wong.
Bulletin of Marine Science BMRSAW, Vol. 47, No. 1, p 68-78, July 1990. 3 fig, 2 tab, 30 ref.

Descriptors: *Cycling nutrients, *Decomposing organic matter, *Hong Kong, *Leaves, *Litter, *Mangrove swamps, *Nutrient concentrations, Calcium, Carbon, Magnesium, Nitrogen, Phosphorus, Potassium.

A preliminary in situ decomposition study, using litter bags, was carried out in a small subtropical mangrove community in Hong Kong from December 1986 to April 1987. Losses in ash-free dry weight, organic C, N, P and other macronutrients (including K, Ca, and Mg) of mangrove leaves were followed biweekly. The results showed that among the three dominant species being studied, Aegiceras corniculatum had the lowest litter bag loss rate, followed by Avicennia marina and Kandelia candel. At the end of 12 weeks' incubation, 12.7%, 60.2% and 32.6% of the original leaf material remained in bags containing K. candel, A. corniculatum and A. marina, respectively. This indicates that A. corniculatum was the most resistant species to leaf decomposition. A. corniculatum had the lowest concentrations of N and P but the widest range of C:N ratio in its leaf when compared with the other two species. This suggests that rate of leaf decomposition might be species specific and is related to the chemical composition of the leaves. Despite the differences in litter bag loss rates among the three species, they all followed the same pattern of degradation which could be described by linear equations. There was an immediate rise in leaf C:N ratio during the first 2 weeks of incubation which then decreased gradually and remained at around 24:1 throughout the rest of the incubation period. In parallel with the decrease in C:N ratios, significant losses of N, P and other macronutrients were observed in A. marina and K. candel which might have been exported from the mangrove zone to foreshore and become an important nutrient source for other marine organisms. (Author's abstract)
W91-03300

METALS IN ULVA LACTUCA IN HONG KONG INTERTIDAL WATERS.
Hong Kong Univ. Dept. of Botany.
For primary bibliographic entry see Field 5B.
W91-03301

STUDIES ON LITTER FALL AND DECOMPOSITION OF BRUGUIERA SEXANGULA (LOUR.) POIR, COMMUNITY ON HAINAN ISLAND, CHINA.
Xiamen Univ. (China). Inst. of Environmental Science.
C. Lu, and P. Lin.
Bulletin of Marine Science BMRSAW, Vol. 47, No. 1, p 139-148, July 1990. 5 fig, 3 tab, 21 ref.

Descriptors: *China, *Decomposing organic matter, *Decomposition, *Hainan, *Litter, *Mangrove swamps, Detritus, Ecosystems, Estuaries, Food chains, Leaves, Nutrients, Seasonal variation.

The litter fall of two Bruguiera sexangula communities at Dongzhai Harbor of Hainan Island was studied for 4 yr, from 1984 to 1987. The mean litter production amounted to 12.55 + or -1.62Mg/hr/yr and 11.04 + or -0.18 Mg/ha/yr (dry matter) respectively in two communities, artificial and natural forest. The monthly production fluctuated not only with the monthly mean air temperature but also with the typhoon and strong wind. The decomposition rate of leaf litter of B. sexangula was measured seasonally from spring to winter in 1984 and 1985 at a mangrove stand. The results showed that the leaf litter decomposition half-times in the four seasons were 21, 20, 26, and 45 days respectively, and that marine animals played an important role in the decomposition process. By providing organic detritus a great deal of mangrove litter is incorporated rapidly into estuarine and coastal ecosystems. Thus mangroves are significant contributors to the food chains of these ecosystems. (Author's abstract)
W91-03302

NUMERICAL SIMULATION OF GROUNDWATER FLOW IN FUHRBERG FIELD, HANOVER.
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 2F.
W91-03320

PHYTOPLANKTONIC BIOMASS AND PRODUCTIVITY IN THE RHONE RIVER PLUME IN SPRING TIME (BIOMASSE ET PRODUCTION PHYTOPLANCTONIQUES DANS LE FRONT DU PANACHE RHODANIEN: SITUATION PRINTANIERE).
Jaffna Univ. (Sri Lanka). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W91-03392

NUMERICAL MODELING OF TIDAL HYDRODYNAMICS AND SALINITY TRANSPORT IN THE INDIAN RIVER LAGOON.
Florida Univ., Gainesville. Dept. of Coastal and Oceanographic Engineering.
Y. P. Sheng, S. Peene, and Y. M. Liu.
Florida Scientist FLSCAQ, Vol. 53, No. 3, p 147-168, Summer 1990. 16 fig, 14 ref.

Descriptors: *Coastal lagoons, *Florida, *Hydrodynamics, *Indian River Lagoon, *Mathematical models, *Model studies, *Salinity, *Solute transport, *Tidal currents, *Water circulation, Mathematical equations, Simulation analysis, Wind.

A one-dimensional model of circulation and salinity transport within the Indian River lagoon system is based on the cross-sectionally averaged continuity equation, momentum equation, mass conservation equation for salt, and equation of state. A fractional step method and time-implicit scheme are used in the finite-difference model. The model is used to examine the role of pure barotrophic tidal hydrodynamics and to explore the time scales of salinity transport in the lagoon. Model simulation of barotrophic tidal circulation in the Indian River lagoon successfully reproduced the water level measured during a 3-day episode in September 1984. Model simulation of tide-induced salinity transport in the Indian River lagoon indicates a very long response time on the order of 100 tidal cycles. The presence of a uniform wind stress of 1 dyne/sq cm from the south enhances the salinity transport and reduces the response time to 10 to 20 tidal cycles. Results indicate that long-term flow and salinity data are needed for understanding and modeling the circulation and salinity transport within the Indian River lagoon. (Author's abstract)
W91-03437

GROUNDWATER SEEPAGE INTO THE INDIAN RIVER LAGOON AT PORT ST. LUCIE.
Florida Inst. of Tech., Melbourne. Dept. of Civil Engineering.
A. Pandit, and C. C. El-Khazen.
Florida Scientist FLSCAQ, Vol. 53, No. 3, p 169-179, Summer 1990. 5 fig, 4 tab, 12 ref. South Florida and St. Johns River Water Management Districts Grants 250-1547 and 250-1598.

Descriptors: *Coastal lagoons, *Estuaries, *Florida, *Groundwater, *Indian River Lagoon, *Mathematical models, *Model studies, *Seepage, *Surface-groundwater relations, Aquifer systems, Clays, Conductivity, Freshwater, Groundwater level, Groundwater movement, Port St Lucie, Saline water.

A finite element program, GROSEEP, was developed to estimate the groundwater seepage from the surficial aquifer into Indian River lagoon along a selected cross-section in Port St. Lucie, Florida. The Indian River lagoon is a semi-enclosed area of 227 sq mi in which freshwater mixes with saltwater. Groundwater levels in the surficial aquifer, along with the groundwater flow direction, are required to operate GROSEEP. The model is a general purpose model and can be used at other cross-sections. Model results using a single layer indicate that groundwater seepage could be an important freshwater source into the lagoon. The annual seepages from the mainland for 1976 and 1977 were calculated to be 1438 and 1625 cu ft per foot of lagoon shoreline, respectively. If the groundwater seepage into the lagoon, all along the shoreline, is the same as that estimated at Port St. Lucie, then the annual seepage into the lagoon from the mainland would be 1.2 billion and 1.33 billion cu ft for 1976 and 1977, respectively. Sensitivity analysis using a three-layer model predicted that the presence of windows in the clay layers, the vertical hydraulic conductivity of the clay layer, and the horizontal conductivity of the sand layer could significantly affect seepage rates into the lagoon. (MacKeen-PTT)
W91-03438

WATER QUALITY CHANGES ASSOCIATED WITH ROTARY DITCHED AND BREACHED MOSQUITO CONTROL IMPOUNDMENTS IN MOSQUITO LAGOON.
East Volusia Mosquito Control District, Daytona Beach, FL.
J. C. Gamble, J. P. Stewart, and W. R. Ehrhardt.
Florida Scientist FLSCAQ, Vol. 53, No. 3, p 180-183, Summer 1990. 1 fig, 2 tab, 1 ref.

Descriptors: *Ditches, *Florida, *Marsh management, *Marshes, *Mosquito Lagoon, *Mosquitoes, *Reservoirs, *Water quality monitoring, Coastal marshes, Dissolved oxygen, Habitats, Mosquito control, Nitrogen, Phosphates, Rotary ditching, Salinity, Turbidity.

A study was conducted for one year before and one year after construction of rotary ditches in breached impoundments to document water quality changes in high marsh pothole habitats. Data collected weekly included salinity, dissolved oxygen, nitrogen, phosphate, and turbidity. Differences between the post-construction and control sites were generally not significant. Some extreme events, particularly high salinity and low dissolved oxygen, were reduced after construction, which may indicate a more stable environment. This stabilization should support a larger population and diversity of fish, contributing to better mosquito control in these habitats. The study is a preliminary step in demonstrating the ability of Open Marsh Water Management by rotary ditching to enhance the high-marsh habitat. (Author's abstract)
W91-03439

SALT MARSH MITIGATION: AN EXAMPLE OF THE PROCESS OF BALANCING MOSQUITO CONTROL, NATURAL RESOURCE, AND DEVELOPMENT INTERESTS.
Indian River Mosquito Control District, Vero Beach, FL.
For primary bibliographic entry see Field 6G.
W91-03441

INTRODUCTION TO THE TIDES OF FLORIDA'S INDIAN RIVER LAGOON: II. CURRENTS.
Harbor Branch Oceanographic Institution, Inc., Fort Pierce, FL.
N. P. Smith.
Florida Scientist FLSCAQ, Vol. 53, No. 3, p 216-225, Summer 1990. 2 fig, 1 tab, 8 ref.

Descriptors: *Florida, *Indian River Lagoon, *Lagoons, *Tidal amplitude, *Tidal currents, *Tides, *Water currents, Fort Pierce Inlet, Phase angles, St Lucie Inlet, St Sebastian Inlet, Tidal waves.

Hourly current measurements recorded along the Atlantic Intracoastal Waterway were used to quantify amplitudes and local phase angles of the principal tidal constituents in Florida's Indian River lagoon. Twenty-seven study sites located between latitudes 27 degrees 10 minutes and 28 degrees 17 minutes N were occupied for periods of 1-2 months each during 1976-1988. Six principal tidal constituents (M2, S2, N2, K1, O1, and P1) had amplitudes greater than the precision of the measurements used to make the calculations. The semidiurnal M2 constituent dominated all other tidal constituents. M2 amplitudes exceeded 60 cm/s in the vicinity of Ft. Pierce Inlet; the amplitude just

north of St. Lucie Inlet was approximately 45 cm/s. M2 amplitudes were relatively small in the vicinity of St. Sebastian Inlet: values of 11 and 19 cm/s were computed from data obtained at study sites approximately 3 km north and south of the inlet, respectively. M2 amplitudes north of 28 degrees 11 minutes N were less than 1 cm/s. A comparison of phase angles indicated that tidal wave forms propagate at speeds of 5-10 km/h. In the central parts of the central and southern segments of the lagoon, the time delay of any phase of the tide is 6.5 and 5 h, respectively, relative to Ft. Pierce Inlet. (Author's abstract)
W91-03442

LARGE SPATIAL AND TEMPORAL BIOLOGICAL VARIABILITY OF INDIAN RIVER LAGOON.
Saint Johns River Water Management District, Palatka, FL.
For primary bibliographic entry see Field 2H.
W91-03443

DEVICE FOR REDUCING THE EFFECTS OF WAVE ACTION IN SHALLOW WATER.
Mount Allison Univ., Sackville (New Brunswick). Dept. of Biology.
T. L. McAllister, and R. B. Aiken.
Hydrobiologia HYDRB8, Vol. 202, No. 1/2, p 105-106, August 29, 1990. 1 fig, 1 ref.

Descriptors: *Baffles, *Check structures, *Estuarine environment, *Experimental design, *Tidal effects, *Tidal marshes, *Wave action, *Wetlands, Bay of Fundy, Canada, Hydraulic design, Hydraulic engineering, Shallow water, Spartina, Tidal flats, Tidal flooding.

In studies of the combined effects of mechanical wave action, reduced light, and salt water during tidal flooding on the metabolism of Spartina grass, it was necessary to experimentally control the effects of each factor. The Bay of Fundy in Atlantic Canada has some of the highest tides in the world. When the tide is approaching, there is considerable wave action and the observed metabolic adaptions may be partially due to the mechanical stress experienced by the plant. A device, consisting of two sets of perforated plywood baffles, was designed to mediate the effects if mechanical wave action during tidal flooding. In the field, the baffles are set up such that the smaller set of baffles is surrounded by the larger set. The plywood is anchored to the substrate by conduit tubing. When the tide approached this baffle system, the outer walls absorbed the initial shock of the wave and the water passed through the holes in the wall and entered the narrow space between the two sets of baffles. The water in this space then trickled through the holes in the second set of baffles and began to fill the area enclosed by the second set. The water level inside the inner set of baffles rose evenly and steadily without any noticeable wave action. Initial attempts to construct this apparatus using heavy-gage plastic were unsuccessful because the flexibility transmitted the force of the wave and created similar wave action inside and outside the baffles. This apparatus is easily built and can be set by two people in about 45 minutes. It is suggested that it could be useful for any investigator studying the effects of wave action on the inhabitants of tidal flats. (Fish-PTT)
W91-03487

ULVA LACTUCA AS BIOINDICATOR OF METAL CONTAMINATION IN INTERTIDAL WATERS IN HONG KONG.
Hong Kong Univ. Dept. of Botany.
For primary bibliographic entry see Field 5A.
W91-03498

EFFECTS OF TERRESTRIAL EFFLUENTS ON THE INCIDENCE OF AEROMONAS SPP. IN COASTAL WATERS.
Barcelona Univ. (Spain). Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W91-03521

SEA LEVEL AND RAINFALL CORRELATIONS IN AUSTRALIA: TROPICAL LINKS.
Flinders Inst. for Atmospheric and Marine Sciences, Bedford Park (Australia).
For primary bibliographic entry see Field 2B.
W91-03523

ECOLOGY OF ESTUARIES. VOLUME II: BIOLOGICAL ASPECTS.
Cook Coll., New Brunswick, NJ. Fisheries and Aquaculture Technology Extension Center.
M. J. Kennish.
CRC Press, Inc., Boca Raton, Florida. 1990. 391p.

Descriptors: *Ecosystems, *Estuaries, *Estuarine environment, Aquatic environment, Aquatic plants, Bacteria, Benthic fauna, Bottom sediments, Coastal environment, Energy, Fish, Food chains, Macroinvertebrates, Phytoplankton, Reviews, Taxonomy, Zooplankton.

The rapid development of estuarine ecology as a field of scientific inquiry reflects a growing awareness of the immense societal importance of these coastal ecosystems. The study of estuaries involves both ecological and societal issues. As a result of the heightened public concern related to the water quality of coastal regions in the U.S., for example, numerous detailed and quantitative research programs were undertaken in the 1960s, 1970s, and 1980s, which provided a basic understanding of the processes operating in many estuaries. The principal objective of this book is to review the biological characteristics of estuaries. Chapter 1 focuses on the bacteria of estuaries. Chapter 2 details the phytoplankton of estuaries, providing coverage of taxonomy, species composition, succession, biomass, and production of this important autotrophic group. Chapter 3 discusses the classification, taxonomy, and ecology of estuarine zooplankton. Chapter 4 recounts the benthos of estuaries, that is, the flora and fauna inhabiting bottom sediments. The spatial distribution of benthic macroinvertebrates is addressed on three levels: (1) small-scale distributions within the estuary; (2) distribution patterns on the scale of the estuary; and (3) distribution patterns on a world scale. Physical factors strongly affect local distributions of the benthos. Chapter 5 reviews the ichthyofauna of estuaries--the largest and most motile component of the estuarine nekton of actively swimming pelagic organisms within the size range of 20 mm to 20 m. Finally, Chapter 6 examines the trophic relationships of estuarine organisms and the flow of energy among producers, consumers, and decomposers. Plants and animals living in estuaries are not isolated entities, but part of a complex food web. Two major interlocking components of the food web exist: (1) the detritus food web, and (2) the grazing food web. Differences between these two pathways of energy flow occur principally at the primary producer-primary consumer levels. (See also W87-09066) (Lantz-PTT)
W91-03658

SENSITIVITY ANALYSIS OF '2D-FED,' A MODEL FOR SEAWATER ENCROACHMENT IN LEAKY COASTAL AQUIFERS.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
M. M. Sherif, V. P. Singh, and A. M. Amer.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 343-356, October 1990. 6 fig, 1 tab, 25 ref.

Descriptors: *Coastal aquifers, *Dispersion, *Finite element method, *Flow pattern, *Groundwater movement, *Model studies, *Saline water intrusion, Aquifer characteristics, Leaky aquifers, Numerical analysis, Rotational flow, Salts, Sensitivity analysis, Simulation analysis.

In a previous study, a two-dimensional finite element model for dispersion (2D-FED) was developed and verified for some previously published problems, and applied to predict the shape of equiconcentration and equipotential lines in coastal aquifers. The 2D-FED model was used to study the effect of several parameters on the simulated dispersion zone and flow pattern in leaky coastal aquifers under steady state conditions. It was found that the aquifer thickness greatly affects the dispersion zone as well as the equipotential lines. Except for certain ranges, the effects of isotropic and anisotropic permeability coefficients and anisotropic dispersivities are relatively small. Cyclic flow is found near the shore boundary, except when the aquifer depth is relatively small, and yet salt ions find their way into the aquifer to some limited distance under the effect of dispersion. Selection of a proper mesh size is very important. Generally, smaller elements accelerate the convergence. Near the shore boundary, where cyclic flow exists, an intensive grid is required to avoid numerical problems. (Author's abstract)
W91-03757

PROPOSALS FOR MACROPHYTE RESTORATION IN EUTROPHIC COASTAL LAGOONS.
Barcelona Univ. (Spain). Dept. de Ecologia.
For primary bibliographic entry see Field 5G.
W91-03797

SUBAERIAL EXPOSURE AND CHANGES IN THE STABILITY OF INTERTIDAL ESTUARINE SEDIMENTS.
Bristol Univ. (England). Dept. of Botany.
D. M. Patterson, R. M. Crawford, and C. Little.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 6, p 541-556, June 1990. 9 fig, 2 tab, 24 ref. NERC special topic grant GST/02/46 and NERC grant GR/3/6402.

Descriptors: *Diatoms, *England, *Estuaries, *Estuarine environment, *Estuarine sediments, *Mud flats, Dehydration, Erosion, Sediment stability, Severn River Estuary, Tamar River Estuary, Tidal effects.

Since factors that affect the erosion of intertidal flats also influence the calculations of sediment budgets for estuarine ecosystems, one of the most important characteristics of the mud is the stability of the surface in terms of the force required to initiate resuspension. Changes in the surface stability of six intertidal mudflats, three sites on each of the Tamar and Severn estuaries in England were determined, and the diatom assemblages present during measurements taken over a full period of subaerial exposure were examined. Hourly measurements were made using a cohesive strength meter which provides an ordinal measure of sediment stability. The sediment was most easily eroded immediately after the emersion of the mudflat and there was little difference between the initial stability of the mud at different sites or stations. As the subaerial exposure continued, the sediment of mid-shore and high-shore stations began to increase in stability. No significant change was found at low-shore stations before the return of the tide. The surface density of diatom populations was also intermittently measured at each site. The greatest increase in sediment stability occurred at high-shore stations and this was most extreme where there were also dense populations of epipelic diatoms present at the surface of the sediment. This supports laboratory evidence that the extracellular products of diatom populations of sufficient density increase the stability of intertidal sediments. The mechanisms by which epipelic diatoms stabilize sediments are related to the physical characteristics of the mucilage produced for locomotion. If the mucopolysaccharide matrix at the surface becomes dehydrated, it is possible that the sediment will become more tightly bound in the thickening matrix. Therefore, dewatering of the sediment and dehydration of the matrix may act together to increase sediment stability. (White-Reimer-PTT)
W91-03813

FISH IN SHALLOW AREAS IN MORETON BAY, QUEENSLAND AND FACTORS AFFECTING THEIR DISTRIBUTION.
Queensland Dept. of Primary Industries, Brisbane (Australia). Fisheries Management Branch.
H. T. Weng.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 6, p 569-578, June 1990. 3 fig, 3 tab, 24 ref.

Descriptors: *Australia, *Estuaries, *Estuarine environment, *Estuarine fisheries, *Fish populations, *Species composition, Distribution, Habitats, Shallow water, Species diversity.

The abundance of species, species diversity, faunal similarity, and some of the factors affecting the distribution of fish in the shallow waters of Moreton Bay, Australia, were examined. Five shallow areas (<4 m in depth) were selected to examine fish communities. These areas were categorized as sand-drifting, sea grass, river mouth, mangrove fringe and sewage outlet. A total of 86 fish species were recorded. Five species (6%) were regarded as true marine fish, but these were of rare occurrence (0.5%). Four species (5%) were highly abundant (51%) and 57 species (66%) were represented by low numbers of fish (5%). The sewage outlet and the river mouth sites were found to contain the highest number of fish with relatively low numbers of species. The sand-drifting and the sea grass sites were different in fish fauna, and both were different from the remaining three sites which were of high similarity in fish faunal groups. Food availability, preference for habitats, sea grass vegetation, juvenile/adult segregation, season of juvenile recruitment and hydrological characteristics were thought to be important factors affecting the distribution of these species of fish. (Author's abstract)
W91-03814

HYDROGRAPHY AND PHYTOPLANKTON OF WATERS OFF SOUTH-WEST IRELAND.
University Coll., Galway (Ireland). Irish Phytoplankton Group.
R. Raine, J. O'Mahony, T. McMahon, and C. Roden.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 6, p 579-592, June 1990. 6 fig 3 tab, 32 ref.

Descriptors: *Coastal waters, *Ireland, *Phytoplankton, *Productivity, *Red tide, Aquaculture, Biomass, Chlorophyll, Diatoms, Dinoflagellates, Fronts, Salinity, Stratification, Temperature, Upwelling.

The danger posed to aquaculture by the periodic development of red tides off southwest Ireland, as well as the unusual plankton ecology of the area resulted in research to determine the factors governing periodic phytoplankton blooms in this area. The study area, which included Roaringwater Bay, Dunmanus Bay, and Bantry Bay, was visited on three occasions from August 1985 to July 1987. Physical, chemical and biological characteristics were measured at twenty-three stations. A number of thermal fronts were identified from both shipboard measurements and satellite imagery. The overall range in surface temperatures encountered during the three cruises was 10.9 to 16.4 C, the coldest surface water was found inside Roaringwater Bay and outside the mouth of Bantry Bay. Salinity of all samples ranged from 34.6 to 35.3 ppt and was not as significant as temperature in determining water column structure. Phytoplankton species composition, although it varied between cruises, was associated with differences in hydrographic features. High phytoplankton standing crop was associated with zones of physical discontinuity. The phytoplankton species composition in frontal regions is typically one of diatoms in mixed or upwelled water and dinoflagellates in the front and thermocline of stratified water. Upwelling was shown to be an important process in the area, and enhanced phytoplankton biomass and productivity were associated with areas of upwelling and the fronts. Although the data strongly suggest that upwelling is a causative mechanism, it does not necessarily follow that the entire area of cool water found off southwest Ireland is solely due to upwelling. Other processes, such as geostrophic effects on advective currents along shore or the propagation of internal waves originating from the shelf-break, may be important. (White-Reimer-PTT)
W91-03815

NEAR-SHORE HYPOXIA IN THE CHESAPEAKE BAY: PATTERNS AND RELATIONSHIPS AMONG PHYSICAL FACTORS.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
D. L. Breitburg.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 6, p 593-609, June 1990. 4 fig, 5 tab, 25 ref. NOAA Office of Sea Grant, U.S. Dept. of Commerce Grants NA85AA-D-SG042, R/DO-1B, and A/DO-1B.

Descriptors: *Anoxia, *Chesapeake Bay, *Dissolved oxygen, *Estuaries, *Hypoxia, *Tidal currents, Salinity, Seasonal variation, Temperature, Wind-driven currents.

Near-shore, shallow waters in the Chesapeake Bay periodically experience episodes of anoxia or severe hypoxia during summer. In order to examine the severity and temporal pattern of hypoxia, and environmental factors that may lead to such episodes, dissolved oxygen, salinity and temperature were measured at 15-min intervals during the summers of 1987 and 1988 in a western shore oyster bed. Average bottom dissolved oxygen concentrations were lower at a 4-m site than at a 2-m site. During episodes of severe hypoxia on the western shore of the bay, oxygen minima: (1) coincided with increased salinities and ebb tides, (2) were preceded by winds from the S-SSE (minima of </= 0.5 mg/L) or SW (minima of 0.6-1.1 mg/L), and (3) were reached during 22.00-06.00 hours. Severe hypoxia at the study site therefore appeared to result from intrusions of bottom water, which were most effectively driven by southerly winds. Tidal currents were required to provide the final force that brought deep water close to shore. The diel pattern of intrusions is most likely caused by winds, which were often too strong or had too weak a southerly component to permit intrusions (without near-shore mixing and reaeration) to occur during afternoon-early evening hours, and the diel periodicity of tides. Short-term fluctuations in temperature and salinity were not as great as fluctuations in dissolved oxygen when compared to seasonal fluctuations of each parameter. For many organisms, short-term fluctuations in temperature and salinity may therefore be less likely to influence the habitability of areas such as the near-shore Chesapeake Bay than are similar duration fluctuations in dissolved oxygen concentrations. (Author's abstract)
W91-03816

ESTIMATION OF DIFFUSE INPUTS TO A COASTAL SEA: SOLUTION TO AN INVERSE MODELLING PROBLEM.
Institut Rudjer Boskovic, Zagreb (Yugoslavia).
T. Legovic, N. Limic, and V. Valkovic.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 6, p 619-634, June 1990. 4 fig, 2 tab, 12 ref.

Descriptors: *Adriatic Sea, *Coastal areas, *Lead, *Model studies, *Path of pollutants, Sediment transport, Solute transport, Transport models.

The input of substances to coastal waters comes from a number of natural sources and activities in shipyards, harbors, and the chemical industry. Since the sources are often diffuse, the inflow rate cannot be determined in a direct way. Measurements of currents and salinity in the Punat Bay (the Adriatic Sea) were used to reconstruct the total current field and to estimate the wash-out rate of water. A two-dimensional transport model and measurements of total concentrations of lead in the water and sediments were used to estimate the sedimentation rate and input. A number of generalizations were necessary in order to apply the model to transport in coastal waters: (1) the concentration was considered as the average value over a longer time period (12 days); (2) the extinction parameter was a function with higher values closer to outfalls; (3) the extinction parameter could not be interpreted merely as the sedimentation rate but as the difference of the sedimentation and recycling rates; and (4) the input was increased by a term that corresponded to the input from the atmosphere and was constant over the whole basin. Good agreement, that verified the results, was obtained where there was an independent set of data or an alternate method of processing the data. This indicated that: (1) measurements of concentrations in both sediment and water were representative; (2) the selected model was satisfactory for quantitative description of the transport of lead in the water of Punat Bay; and (3) the method of estimating diffuse inputs works well with the selected transport model even with a relatively modest numerical resolution. (White-Reimer-PTT)
W91-03817

NATURE OF POC TRANSPORT IN A MANGROVE ECOSYSTEM: A CARBON STABLE ISOTOPIC STUDY.
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
C. E. Renzende, L. D. Lacerda, A. R. C. Ovalle, C. A. R. Silva, and L. A. Martinelli.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 6, p 641-645, June 1990. 2 fig, 1 tab, 14 ref.

Descriptors: *Brazil, *Carbon cycle, *Isotope studies, *Mangrove swamps, *Organic carbon, Carbon isotopes, Suspended matter, Tidal currents.

Carbon stable isotope measurements have been used as a consistent tracer of organic carbon in mass balance studies in salt marsh and seagrass beds. They have also been used to characterize suspended organic matter in coastal waters to trace coastal food webs and the sources of soil and sediment organic carbon. The isotopic composition of particulate organic carbon (POC) was studied during five tidal cycles in a mangrove creek of Sepetiba Bay, Rio de Janeiro, Brazil. Quantification of the relative contribution of Bay's (marine) and mangrove POC in suspended matter was calculated according to a two-end-member model. The results show that a mixture of organic carbon from mangrove and marine origins is always present in the creek. Mean mangrove contribution to the POC varied from 16% to 100% and was dependent on tidal amplitude. The results suggest that oceanic carbon can be an important component of carbon balance in mangrove ecosystems. Therefore, earlier carbon balance studies from mangroves which did not include measurements of carbon isotopic composition should be interpreted with care. (White-Reimer-PTT)
W91-03818

DISTRIBUTION AND TEXTURE OF THE BOTTOM SEDIMENTS IN A SEMI-ENCLOSED COASTAL INLET, THE ISMIT BAY FROM THE EASTERN SEA OF MARMARA (TURKEY).
Middle East Technical Univ., Mersin (Turkey). Inst. of Marine Sciences.
M. Ergin, and R. Yoruk.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 6, p 647-654, June 1990. 3 fig, 29 ref.

Descriptors: *Bottom sediments, *Organic carbon, *Sea of Marmara, *Sediment distribution, *Turkey, Calcareous organisms, Carbonates, Gravel, Izmit Bay, Sand, Silt, Surficial sediments.

In order to gain a better understanding of the recent hydrographic and biological processes in Izmit Bay in the Eastern Sea of Marmara, Turkey, the types and modes of distribution of the surficial bottom sediments were studied. Thirty-one surficial sediment samples were collected from the floor of the bay with a grab sampler in the summer of 1987, and analyzed for their grain size, total carbonate, and organic carbon distribution. Low calcareous-terrigenous mud (2-45% CaCO3) with a relatively high silt percentage was the principal sediment type found on the floor of Izmit Bay. Sediments rich in sand and gravel usually occur in the narrow and shoal areas of the bay, where biogenic and topography-related hydrodynamic conditions are the dominant factors controlling the nature of bottom deposits. The carbonates are made up almost entirely of the remains of calcareous organisms. Organic carbon concentrations of the sediments (0.35-1.62%) are probably associated with the high primary production rates in this region. Thus, the rates of sedimentation in Izmit Bay calculated from the organic carbon and pri-

mary productivity data are estimated to be up to 70 cm/1000 years. (Author's abstract)
W91-03819

REMARKABLE INVASION OF SAN FRANCISCO BAY (CALIFORNIA, USA) BY THE ASIAN CLAM POTAMOCORBULA AMURENSIS. II. DISPLACEMENT OF A FORMER COMMUNITY.
Geological Survey, Menlo Park, CA. Water Resources Div.
F. H. Nichols, J. K. Thompson, and L. E. Schemel.
Marine Ecology Progress Series MESEDT, Vol. 66, No. 1/2, p 95-101, September 1990. 6 fig, 18 ref.

Descriptors: *Clams, *Estuaries, *Estuarine environment, *Introduced species, *Mollusks, *San Francisco Bay, Bivalves, Community structure, Salinity.

Long-term macrobenthic sampling at a site in northern San Francisco Bay has provided an unusual opportunity for documenting the time course of an invasion by a recently introduced Asian clam Potamocorbula amurensis. Between 1977, when sampling began, and 1986, when the new clam was first discovered, the benthic community varied predictably in response to river inflow. During years of normal or high river inflow, the community consisted of a few brackish or freshwater species. During prolonged periods of low river inflow, the number of species doubled as estuarine species (e.g. Mya arenaria) migrated up the estuary. In June 1987, at the beginning of the longest dry period in recent decades, large numbers (>12,000/sq m) of juvenile P. amurensis were discovered at the site. By mid-summer 1988 the new clam predominated (>95%) in both total number of individuals and biomass, and the expected dry-period estuarine species did not become reestablished. The rapid rise of P. amurensis to numerical dominance throughout the region of the original introduction was probably facilitated by the fact that this region of the bay had been rendered nearly depauperate by a major flood in early 1986. Once introduced, the clam had sufficient time (>1 yr) to become well established before the salinity regime was appropriate for the return of the estuarine species. Subsequently, the new clam was apparently able to prevent the return of the dry-period community. Its ability to live in low salinity water (<1 ppt) suggests that P. amurensis may not be displaced with the return of normal winter river flow and, therefore, may have permanently changed benthic community dynamics in this region of San Francisco Bay. (Author's abstract)
W91-03831

MACROFAUNA RECOLONIZATION OF SUBTIDAL SEDIMENTS. EXPERIMENTAL STUDIES ON DEFAUNATED SEDIMENT CONTAMINATED WITH CRUDE OIL IN TWO NORWEGIAN FJORDS WITH UNEQUAL EUTROPHICATION STATUS. I. COMMUNITY RESPONSES.
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 5C.
W91-03832

INCREASE OF BENTHIC BIOMASS IN THE SKAGERRAK-KATTEGAT DURING THE 1970S AND 1980S--EFFECTS OF ORGANIC ENRICHMENT.
Groelands Fiskeriundersoegelser, Charlottenlund (Denmark).
For primary bibliographic entry see Field 5C.
W91-03833

ARE ESTUARIES TRAPS FOR ANTHROPOGENIC NUTRIENTS: EVIDENCE FROM ESTUARINE MESOCOSMS.
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
B. L. Nowicki, and C. A. Oviatt.
Marine Ecology Progress Series MESEDT, Vol. 66, No. 1/2, p 131-146, September 1990. 5 fig, 6 tab, 67 ref. EPA grant CR 812487-01-1.

Descriptors: *Cycling nutrients, *Estuaries, *Eutrophication, *Nitrogen, *Phosphorus, Mass balance, Narragansett Bay, Nutrient budget, Nutrient retention, Nutrient sources, Sediments, Water column.

A successful understanding of the role of estuaries as nutrient traps, filters, or exporters requires a knowledge of the distribution of dissolved and particulate nutrient species was well as their rates of input, loss, and accumulation in coastal waters. The results of nutrient mass balances for control and eutrophied artificial mesocosms, with and without sediment communities are presented. Nutrient budgets were prepared for 6 mesocosms by quantifying all sources and sinks of inorganic and organic dissolved and particulate N and P. Measurements included inputs of N and P in inflowing water from adjacent Narragansett Bay, in rain, snow, and atmospheric dry deposition, and outputs of N and P in outflowing water, in losses to denitrification, to burial and to increases in biomass. Regardless of treatment or season these experimental systems exported most of the N and P that they received. Control systems with sediments retained none of the inflowing N and P during summer, and 5% of N and 25% of P inputs during winter. Eutrophied systems with sediments initially retained 30% of added N and P due to increases in water column and sediment nutrient standing stocks in response to daily inorganic nutrient additions; however, after 6 mo. of daily nutrient loading, these treatments retained only 5 to 15% of nutrients added. Results of this study suggest that well-mixed estuarine systems may export to offshore waters most of the nitrogen and phosphorus that they receive. For the small percentage of nutrients that were retained, there was more storage during winter than summer, more storage in treatments without sediments, and more retention of P than N. Nitrogen losses through sediment denitrification accounted for 10 to 20% of the N input to controls, and less than 10% of the N input to eutrophied treatments. The addition of nutrients to the eutrophied treatments resulted in increases in the N and P content of surface sediments, and the rapid deposition of an N and P-rich detrital layer on the bottom of the treatments without sediments. (Author's abstract)
W91-03834

NITROGEN CYCLING IN SEDIMENTS WITH ESTUARINE POPULATIONS OF POTAMOGETON PERFOLIATUS AND ZOSTERA MARINA.
Maryland Univ., Cambridge. Horn Point Environmental Labs.
J. M. Caffrey, and W. M. Kemp.
Marine Ecology Progress Series MESEDT, Vol. 66, No. 1/2, p 147-160, 1990. 7 fig, 4 tab, 64 ref. NSF Grant BSR 8801259.

Descriptors: *Cycling nutrients, *Denitrification, *Estuaries, *Macrophytes, *Nitrification, *Nitrogen, Ammonia, Biomass, Eelgrass, Grassbeds, Nitrates, Nitrites, Potamogeton, Seasonal variation, Sediments.

Rates of nitrogen transformation and concentrations of extractable NH4(+) and NO3(-) (plus NO2(-)) were measured in estuarine sediments vegetated with the submersed macrophytes Potamogeton perfoliatus and Zostera marina, and in adjacent bare sediments, 3 or 4 times during the growing season. The sediments were collected from areas located near the Choptank River, a tributary of Chesapeake Bay. In general, rates were significantly higher in vegetated compared to bare sediments. In P. perfoliatus beds, ammonification and potential nitrification rates were correlated. Both exhibited summer maxima coinciding with peak plant biomass and productivity. Although vertically integrated (0-12 cm), ammonification rates were about twice as high in vegetated as in bare sediments; NH4(+) pools were significantly lower, probably due to high plant nitrogen demand. In contrast, denitrification rates were highest in spring when NO3(-) concentrations peaked, and were significantly correlated to nitrification rates in both spring and fall. Denitrification was only about 20% of total NO3(-) reduction, suggesting that NH4(+) production from NO3(-) may be important in conserving nitrogen within the grassbed. In sediments with Z. marina, rates of ammonification, and nitrification and denitrification potentials each exhibited a distinct seasonal cycle, indicating that rates were not as tightly coupled as in P. perfoliatus beds. High ammonification rates exceeded plant demand leading to NH4(+) accumulation. Potential nitrification rates were highest in vegetated sediments during fall. Denitrification rates, which were also greater in vegetated than in bare sediments, were highest in spring when NO3(-) concentrations were high. Potential denitrification rates comprised 10% of total NO3(-) reduction, indicating that NO3(-) reduction to NH4(+) dominated. The microbial communities responsible for key nitrogen transformations in the sediments were enhanced by both P. perfoliatus and Z. marina: ammonification by inputs of organic nitrogen; nitrification by release of O2 by plant roots; and denitrification by production of NO3(-). (Author's abstract)
W91-03835

DISSOLVED FREE AMINO ACID CYCLING IN AN ESTUARINE OUTFLOW PLUME.
University of Southern California, Los Angeles. Dept. of Biological Sciences.
J. Fuhrman.
Marine Ecology Progress Series MESEDT, Vol. 66, No. 1/2, p 197-203, 1990. 1 fig, 3 tab, 20 ref. NSF grants OCE8406712, OCE8716903, OCE8410074, and OCE8711132.

Descriptors: *Amino acids, *Carbon, *Chesapeake Bay, *Cycling nutrients, *Estuaries, *Nitrogen, Diurnal variation, Productivity, Seasonal variation.

Microbial cycling of dissolved organic C and N is a major pathway in marine ecosystems, and dissolved free amino acids (DFAAs) are significant components of this cycling. Measurements from 4 cruises (February, June, August 1985 and April 1986) in the outflow plume of Chesapeake Bay show that DFAAs cycle rapidly, with turnover times averaging 0.5 to 1 h in spring and summer and ca 3 h in winter, as measured by brief (10 min) tritiated tracer uptake and respiration experiments under extremely clean conditions. DFAA uptake and release rates, calculated from turnover and concentration measurements of four of the most abundant amino acids (glu, ser, gly, ala) as the ship followed a surface drogue, were closely coupled and varied over the day, often tending to be highest near noon and lowest at night, suggesting a connection to primary production. Rates also tended to decline as the relatively biologically-rich plume water mixed with less active coastal seawater. Winter rates were much lower than those in spring and summer. Despite concentrations in the low nM range, the release and uptake rates of these 4 amino acids represented a significant fraction (4 to 18%) of the primary production rate, and incorporation of DFAA-C was 15 to 64% of estimated bacterial secondary production. N uptake from these 4 DFAAs represented about 44 to 131% of the calculated bacterial N demand suggesting that the bacteria in this system probably regenerate inorganic N. One set of measurements in the Hudson plume in summer showed even faster DFAA cycling, with turnover times averaging <7 min. Rapid turnover indicates that the relative extent of molecular (slow) and eddy (fast) diffusion of DFAAs between sources (various plankton) and sinks (mostly bacteria) may be a major rate-controlling factor at scales on the order of mm. The rapid turnover in both plumes suggests that DFAAs are not advected more than a few km, and tend to cycle within a small volume of water. (Author's abstract)
W91-03836

DETECTION OF INITIAL EFFECTS OF POLLUTION ON MARINE BENTHOS: AN EXAMPLE FROM THE EKOFISK AND ELDFISK OILFIELDS, NORTH SEA.
Oslo Univ. (Norway). Inst. of Marine Biology.
For primary bibliographic entry see Field 5C.
W91-03837

SPATIO-TEMPORAL MOSAIC OF THE PHYTOPLANKTON SPRING BLOOM IN THE OPEN BALTIC SEA IN 1986.
Institute of Ecology and Marine Research, Tallinn (USSR).
M. Kahru, J. M. Leppanen, S. Nommann, U. Passow, and L. Postel.
Marine Ecology Progress Series MESEDT, Vol. 66, No. 3, p 301-309, September 1990. 10 fig, 22 ref.

Descriptors: *Algal blooms, *Baltic Sea, *Phytoplankton, *Seasonal variation, *Temporal variability, Chlorophyll, Cycling nutrients, Eddies, Salinity, Sedimentation.

The spatio-temporal variability of the phytoplankton spring blooms, based on chlorophyll concentrations, was studied in relation to the hydrographic structures in the open Baltic Sea during April and May 1986. It was determined that onset of the bloom was controlled by mesoscale hydrodynamic features--a pair of cyclonic and anticyclonic eddies, and water masses with different salinities. The eddies supported an exceptionally high amount of chlorophyll (>700 mg/sq m in the cyclonic eddy). The temporal development of the bloom was different in each of the mesoscale features. Chlorophyll levels in the eddies started to decrease due to sedimentation before formation of the thermocline and the depletion of inorganic nutrients. Variability of the chlorophyll distribution was highest just before the peak in the spatially averaged concentration was attained. Very high chlorophyll values such as those in the water column of the 2 eddies have not been previously reported in the Central Baltic Sea. The vernal growth period holds a key position in determining the response of the Baltic Sea ecosystem to the observed increase in winter nutrient levels. The structure and functioning of the pelagic food web during that phase determine how much nutrient from the initial reserves is transported out of the pelagic system by sedimentation, and how much is retained for recycling in the upper water layer. The spring bloom period should therefore receive more attention when evaluating trends in the trophic state of the sea. (White-Reimer-PTT)
W91-03838

OPTIMAL BATHYMETRY OF TYRRHENIAN SEA BY STOCHASTIC INTERPOLATORS.
Padua Univ. (Italy). Dipt. di Metodi e Modelli Matematici per le Scienze Applicate.
For primary bibliographic entry see Field 5B.
W91-03862

BACTERIAL CONTAMINATION AND REMEDIATION MEASURES AT MARINA DEL REY, CALIFORNIA, U.S.A.
Los Angeles County Dept. of Beaches and Harbors, CA.
For primary bibliographic entry see Field 5B.
W91-03872

PRIMARY PRODUCTIVITY AND PARTICULATE ORGANIC MATTER FLOW IN AN ESTUARINE MANGROVE-WETLAND IN HONG KONG.
Hong Kong Univ. Dept. of Zoology.
S. Y. Lee.
Marine Biology MBIOAJ, Vol. 106, No. 3, p 453-463, 1990. 4 fig, 5 tab, 83 ref.

Descriptors: *Estuaries, *Hong Kong, *Mangrove swamps, *Organic matter, *Particulate matter, *Primary productivity, *Wetlands, Algae, Biomass, Detritus, Ecosystems, Phytoplankton.

Net primary productivity and organic matter flow of a mangrove dominated wetland was estimated by following production and detritus dynamics in a tidal pond in northwest Hong Kong in 1986-1988 (9.1 ha). Total productivity was 12.47 t dry wt/ha/yr, of which > 90% was from emergent macrophytes (the mangrove Kandelia candel and the reed Phragmites communis). High turbidity and high summer temperatures probably limited respective production by phytoplankton and benthic macroalgae (dominated by Enteromorpha crinata). Despite the high total productivity, little detritus was exported from the emergent macrophyte stands due to low inundation. This created a net water column carbon deficit which was provided for by the high organic matter import (mean = 4.42 g ash free dry wt/sq m/d) from incoming water. This same sediment and particulate organic carbon input giving a high accretion rate of 1.7 cm/yr was probably also the force behind progressive dis-coupling of emergent macrophyte production from water column consumers. This resulted in a tendency to retain production in the emergent macrophyte stands while the water column community increasingly relied on allochthonous carbon. This shift from a net exporter to a net importer of carbon in landward wetlands is probably characteristic of the transition into nutrient conservative terrestrial systems. (Author's abstract)
W91-03882

ALTERATIONS IN THE ENERGY METABOLISM OF AN ESTUARINE MYSID (MYSIDOPSIS BAHIA) AS INDICATORS OF STRESS FROM CHRONIC PESTICIDE EXPOSURE.
Environmental Research Lab., Gulf Breeze, FL.
For primary bibliographic entry see Field 5C.
W91-03883

EFFECTS OF AN OIL SPILL ON THE GASTROPODS OF A TROPICAL INTERTIDAL REEF FLAT.
Smithsonian Tropical Research Inst., Balboa (Panama).
For primary bibliographic entry see Field 5C.
W91-03887

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

SALINE WATER DISPOSAL OPTIONS IN THE MURRAY BASIN.
Rural Water Commission of Victoria, Armidale (Australia). Investigations Branch.
For primary bibliographic entry see Field 3C.
W91-03891

3B. Water Yield Improvement

COMPREHENSIVE WATER SHORTAGE PLANNING IN THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT.
Southwest Florida Water Management District, Brooksville.
For primary bibliographic entry see Field 6A.
W91-03040

MAIN INDUCED CHANGES IN RAINFALL-RUNOFF RELATIONSHIP FOR A MOUNTAINOUS WATERSHED.
Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
For primary bibliographic entry see Field 2A.
W91-03432

WATER HARVESTING FOR PLANT PRODUCTION.
Vrije Univ., Amsterdam (Netherlands).
C. Reij, P. Mulder, and L. Begemann.
The World Bank, Washington, DC. World Bank Technical Paper No. 91, 1988. 123p, 10 fig, 4 tab, 14 photo, 384 ref.

Descriptors: *Agricultural water, *Crop production, *Sub-Saharan Africa, *Water harvesting, *Water use, Developing countries, Economic aspects, Literature review, Semiarid lands, Social aspects.

A comprehensive review of the available literature on water harvesting for plant production covers a broad range of topics, including terminology and classification, environmental factors, production aspects and socio-economic issues. Although the report covers publications from various continents, special attention is paid to information on water harvesting in Sub-Saharan Africa. It is quite commonly believed that water harvesting can significantly increase plant production in the arid and semi-arid tropics. The available information does not always support this view. In several countries, substantial research has been done on specific water harvesting techniques, and interesting yields have been obtained at research stations, but these techniques have not been adopted on a significant scale by farmers. Most water harvesting projects in Sub-Saharan Africa are still carried out on a 'trial and error basis'. They do not systematically monitor the impact of water harvesting on yields and sometimes promote packages costing more than $1,000/ha, which significantly reduces their replicability. It is recommended that water harvesting packages be based as much as possible on indigenous techniques and local environmental knowledge. (Author's abstract)
W91-03649

3C. Use Of Water Of Impaired Quality

IRRIGATING SOD FARMS WITH RECLAIMED WATER.
R. Daily.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 119-121.

Descriptors: *Farms, *Irrigation, *Reclaimed water, *Sod farms, *Wastewater utilization, *Water reuse, Algae, Filtration, Fungi, Methyl bromide, Runoff, Soil amendments, Wastewater treatment, Water conservation, Water resources management, Weeds.

A 140-acre sod farm in Temecula has been irrigated with reclaimed water, exclusively, for the last seven years. Irrigation begins early in the morning, usually 3:00 or 3:30 a.m. so that it is complete before the winds come up in the afternoon. Before the first crop is planted the ground is fumigated with methyl bromide, primarily to get rid of the weed and soil-borne fungi. It costs about $1,000 per acre. An aggressive program of soil amendment is used prior to the plow and disk. When using reclaimed water on a sod farm, it is necessary to add soil sulfur to reduce the salt. This prevents the sod from yellowing. Another important feature is perfectly level ground. Low spots cause water to pond. The sun heats the water and the sod burns and dies. A 1.5 million gallon reservoir on the farm receives the reclaimed water. Although algae had been a problem in the reservoir, a solution was found by installing two continuously-operating filters that discharge the filtered water back into the pond through two high-pressure nozzles. The water cascades through the air back into the reservoir at the leeward end where prevailing winds accumulate the algae. It appears that the cascading water puts in so much oxygen that it kills the algae. The farm was laser-leveled to drain to the centrally located reservoir such that all excess irrigation water returns to the reservoir. Thus the runoff is reclaimed and used for irrigation also. In seven years there have been no incidents of water-borne illnesses of sicknesses. (See also W91-03273) (Agostine-PTT)
W91-03287

GOLF COURSE IRRIGATION WITH RECLAIMED WATER.
Moulton Niguel Water District, Laguna Niguel, CA.
J. Smith, and L. Renteria.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 123-126.

Descriptors: *California, *Golf courses, *Irrigation, *Reclaimed water, *Water resources management, *Water reuse, Chlorination, Coagulation, Disinfection, Effluents, Filtration, Flocculation, Legal aspects, Recreation, Secondary wastewater treatment, Sludge, Wastewater treatment, Wastewater utilization, Water conservation.

The first wastewater treatment plant for the Moulton Niguel Water District was built in 1964. It served until 1982 when it was replaced by the Aliso Water Management Agency's (AWMA) Joint Regional Treatment Plant. This state-of-the-art wastewater plant can process up to 12 million gallons per day of wastewater and to 25 million gallons per day of solids (sludge). Effluent from the secondary treatment plant can go to any of three places: directly to the ocean, to the equalization pond and eventually to the ocean, to the tertiary treatment plant for filtration. The filtration system consists of flocculators for mixing coagulating chemicals, sedimentation tanks, filters and chlorination basins for disinfection that hold water for a minimum of two hours after chlorination. The water produced meets all requirements of California's Title 22 health standards and can be used in all reclaimed water applications. A distribution pipeline is used to deliver reclaimed water from Moulton Niguel to the privately owned El Niguel Country Club. The water is delivered into a large holding pond on the golf course. The irrigation system works as follows. The water is pumped to the north end of the reclamation lake, located between the tenth and seventeenth holes, right next to the maintenance yard. From there it is pumped into a VT3 Toro system, and distributed to the irrigation sets through 630 electric valves. Two years ago a separate potable water system was installed to supply the greens and clubhouse. It was suspected that the greens might be a little sick because of the reclaimed water. The negatives of the effluent are the algae buildup problems and the occasional odor problem. The plus is the price of the water. (See also W91-03273) (Agostine-PTT)
W91-03288

FREEWAY LANDSCAPE IRRIGATION IN SAN DIEGO COUNTY.
T. Ham.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 127-132.

Descriptors: *California, *Highway beautification, *Irrigation, *Landscaping, *Reclaimed water, *Water reuse, Economic aspects, Financing, Legal aspects, Wastewater facilities, Wastewater utilization, Water resources management.

Caltrans uses about 48,000 acre-feet of water every year statewide, 35,500 of which is used for highway planting. There are currently about 650 acres statewide on reclaimed water, 500 of which are in southern California. Two water reclamation projects have been completed in the Caltrans right-of-way, one in Mission Valley and one in the city of Oceanside. The Mission Valley project irrigates Route 15 north of 8 to Tierra Santa Boulevard. This project was completed in 1986. An aquaculture plant provides water to about 170 acres of planting on Route 15. A 6-inch main water transmission line was built from the pump house at the aquaculture plant to the landscape areas about four miles away. Water is pumped out at a pressure of 160 to 180 psi. The plan is for a ten year payback. The system capacity is approximately 180 gallons per minute. The Oceanside project, which began operation in 1987, waters approximately 100 acres of planting along I-5 throughout Oceanside from camp Pendleton south to highway 78 in Carlsbad. Since the water is delivered from the Fallbrook Sanitary Sewer District which is 18.5 miles away and 620 feet above Oceanside, the water can be under pressures of 250 psi or more. It is necessary to throttle it down to about 140 psi. The payback period is 12 to 15 years. The steps involved in establishing a reclaimed water project are straightforward. First there must be a source of reclaimed water. Next the approval of the Regional Water Quality Control Board is needed. Both the potable water and the reclaimed water suppliers must be coordinated. It is essential to assure absolute separation of the two supplies. Each step becomes part of the effort and cost of switching to reclaimed water. With proper planning these simple steps can lead to success in the reclaimed water irrigation business. (See also W91-03273) (Agostine-PTT)
W91-03289

INTERACTIVE EFFECTS OF SALINITY AND CALCIUM ON HYDRAULIC CONDUCTIVITY, OSMOTIC ADJUSTMENT, AND GROWTH IN PRIMARY ROOTS OF MAIZE SEEDLINGS.
Technion - Israel Inst. of Tech., Haifa. Faculty of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W91-03520

CROPPING STRATEGIES FOR EFFICIENT USE OF WATER AND NITROGEN.
For primary bibliographic entry see Field 3F.
W91-03633

SALINE WATER DISPOSAL OPTIONS IN THE MURRAY BASIN.
Rural Water Commission of Victoria, Armidale (Australia). Investigations Branch.
R. S. Evans.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 167-185, 1990. 10 fig, 5 tab, 25 ref.

Descriptors: *Australia, *Desalination, *Environmental policy, *Impaired water use, *Murray-Darling River Basin, *Saline water, *Water quality, *Water quality management, Brine disposal, Economic aspects, Ecosystems, Environmental effects, Evaporation pans, Geohydrology, Political aspects, Water reuse.

Large volumes of saline water are produced in the Murray Basin, principally from naturally-occurring saline groundwater discharge to rivers and lakes, and discharge induced by land use change and subsurface drainage effluent from irrigation areas. Disposal of this saline water is fundamental to salinity and land management strategies. River Murray options are either as uncontrolled outflow (non-point saline inflows) or controlled outflow (e.g., groundwater pumping, flushing of evaporation basins). Non-River Murray options are evaporation basins (with or without salt harvesting), aquifer disposal, desalinization, and pipelines to the sea. A key factor in the economics of disposal is salinity of the water. For low-salinity water, reuse and controlled outfall via the River Murray are clearly most economic. As salinity increases, evaporation basins become more economic. Most other options are much more expensive. Public perceptions of feasible disposal options are often poor. Environmental effects can be grouped into those with short term costs to the ecosystem and those with long term hydrogeological consequences. Investigation and evaluation of environmental effects of the major salt disposal options (principally evaporation basins) are now becoming key factors in the choice of the preferred option. An effective saline water disposal strategy for the Murray Basin is one of the highest priorities in salinity management. Economic and environmentally acceptable options now exist, although they may be politically difficult at the local scale. More consideration of how to manage the naturally-occurring discharge areas of the Mallee region may have significant long-term benefits. Best use should be made of all technically and environmentally feasible disposal sites. (Author's abstract)
W91-03891

3D. Conservation In Domestic and Municipal Use

PLANNING TOOL FOR WATER CONSERVATION.
Brown and Caldwell, Tampa, FL.
For primary bibliographic entry see Field 6A.
W91-03091

WATER RECLAMATION: HERE, NOW...AND HOW.
For primary bibliographic entry see Field 5D.
W91-03273

PLANNING FOR WATER RECLAMATION IN SOUTHERN CALIFORNIA.
Irvine Ranch Water District, CA.
R. Young.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 11-18.

Descriptors: *California, *Reclaimed water, *Wastewater treatment, *Water resources management, *Water reuse, *Water treatment, Conservation, Irrigation, Wastewater irrigation, Wastewater utilization.

Irvine Ranch Water District (IRWD) is located in Irvine, California, roughly in the middle of the metropolitan water district of southern California's service area. At 100,000 acres in size, it serves a population of 100,000, with an ultimate population forecast of over 300,000. The IRWD was formed in 1961 and has been practicing water reclamation since 1967. Last year about 9,000 acre-feet of reclaimed water was used, and that amount is growing each year. The reclaimed water is used for two general purposes: landscape irrigation and agricultural irrigation. Landscape uses account for about 6,000 acre-feet, or two-thirds of the reclaimed water demand. Reclaimed water is also put into a distribution system developed by farmers and landowners, commingled with locally captured waters and then used on row crops and truck crops. There are no restrictions on the types of crops that can be irrigated with reclaimed water provided the water meets the highest quality standards of Title 22. To meet these requirements a normal wastewater treatment process is used: primary treatment, conventional activated sludge secondary treatment, followed by direct filtration and disinfection. The water then goes to open-reservoir storage, using reservoirs that once captured local runoff. The idea of using reclaimed water to flush toilets in high-rise offices is being explored. IRDW recently provided reclaimed water to flush toilets in a new public restroom in one of the parks irrigated with reclaimed water. It has been concluded that this type of reuse can be expanded to hotels, schools and other office-type buildings. It is concluded that the processes being used treat the wastewater so that it can be safely reclaimed, that it doesn't have adverse health effects, and that it can be done as a normal standard of practice. (See also W91-03273) (Agostine-PTT)
W91-03275

3E. Conservation In Industry

WATER POLLUTION ABATEMENT EXPENDITURES IN THE WISCONSIN PAPER INDUSTRY.
Wisconsin Univ.-Madison.
For primary bibliographic entry see Field 5G.
W91-03589

3F. Conservation In Agriculture

INFORMATION EXCHANGE ON MODELS AND DATA NEEDS RELATING TO THE IMPACT OF AGRICULTURAL PRACTICES ON WATER QUALITY: WORKSHOP PROCEEDINGS.
For primary bibliographic entry see Field 5G.
W91-02985

PROCESS RESEARCH STRATEGY TEAMS.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 5G.
W91-02988

DEVELOPMENT OF DECISION AIDS.
For primary bibliographic entry see Field 6B.
W91-02991

WATER USE EFFICIENCY UNDER DRIP IRRIGATION: SOME FINDINGS FROM HAWAII.
Hawaii Univ., Honolulu. Dept. of Agricultural and Resource Economics.
R. B. Shrestha, and C. Gopalakrishnan.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 13B-15--13B-26, 3 tab, 12 ref.

Descriptors: *Agricultural water, *Drip irrigation, *Hawaii, *Irrigation practices, *Water conservation, Agricultural hydrology, Soil moisture retention, Soil properties, Sugars.

Drip irrigation has been adopted in Hawaii's sugar industry as a better alternative to furrow or sprinkler irrigation in order to increase yield and conserve water. However, the success of drip technology depends heavily on land quality characteristics such as soil type, water holding capacity, and field gradient, over and above other management and cultural practices. Drip irrigation is found to augment land quality characteristics, especially in the water retention function of soil. The previously marginal productivity of water has shown significant improvement under drip irrigation, resulting in enhanced sugar yield. Drip irrigation has proven to be a preferred alternative to furrow irrigation due mainly to demonstrated increases in yield of about 1.7 tons of sugar/acre (15%) and about a 12% reduction in water useage. (See also W91-03032) (Lantz-PTT)
W91-03092

SOIL EROSION AND CONSERVATION.
For primary bibliographic entry see Field 2J.
W91-03117

CONSEQUENCES OF HEAVY MECHANIZATION AND NEW ROTATION ON RUNOFF AND ON LOESSIAL DEGRADATION IN NORTHERN FRANCE.
Office de la Recherche Scientifique et Technique Outre-Mer, Paris (France).
For primary bibliographic entry see Field 4C.
W91-03121

SOIL AND WATER CONSERVATION PROBLEMS IN THE CENTRAL PLAINS OF VENEZUELA.
Universidad Central de Venezuela, Maracay. Facultad de Agronoma.
For primary bibliographic entry see Field 4D.
W91-03123

WITHIN-FURROW EROSION AND DEPOSITION OF SEDIMENT AND PHOSPHORUS.
Agricultural Research Service, Kimberly, ID. Snake River Conservation Research Center.
M. J. Brown.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 113-118, 3 tab, 3 ref.

Descriptors: *Furrow irrigation, *Idaho, *Irrigation practices, *Phosphorus, *Sedimentation, *Soil erosion, Infiltration, Mulches, Nutrients, Phosphorus losses.

Under present management systems, irrigation drainage streams continually load sediment into streams and rivers. This study sought to determine (1) the erosion and/or deposition pattern within the furrow of various furrow-irrigated crops; (2) the total sediment and P losses from the furrow during each irrigation throughout the irrigation season; and (3) how effective loose straw in furrows would be as an energy dissipator to reduce erosion and increase infiltration. The irrigation system studied was in southern Idaho where potato or bean were being cultivated. During the growing season on the potato plots, six irrigations yielded 13.7 t/ha of sediment and 5 irrigations yielded 7.9 kg/ha of total P. Water flow through the furrow ranged from 15.8 L/min to 6.4 L/min. During six irrigations, 59% of the total sediment loss occurred during the first two irrigations and 85% occurred during the first three irrigations. On a bean field with flat-end furrows, the area of erosion and deposition of sediment and P changed along the furrows from irrigation to irrigation during the season. The flow rate in the furrows for eight irrigations ranged from 14.2 to 22.6 L/min. The greatest erosion and some deposition occurred in the upper half of the furrows; further erosion and most of the sediment deposition occurred in the lower one-third of the furrows. Flow rates in wheel rows ranged from 14.2 to 18.4 L/min; rates in the nonwheel rows ranged from 15.2 to 22.6 L/min. During the first two irrigations on the flat-end bean field, 49% of the total sediment eroded left the furrows. Only 23% of the total eroded sediment was lost during the last four irrigations. On the bean field with convex-end furrows, erosion was greatest in the bottom one-third of the furrows. Erosion in the upper two-thirds of the furrows was similar to that in the upper two-thirds of the flat-end field. Loose straw in the furrows reduced sediment generated from erosion by 71%; entering stream sizes were 13.2 and 10.3 L/min for the straw and no-straw furrows, respectively. Straw also increased infiltration by 82% compared to no-straw furrows. Proper use of organic matter and better water management in the early part of the season could effectively increase infiltration and reduce soil and nutrient losses. (See also W91-03117) (Rochester-PTT)
W91-03127

SOIL AND WATER CONSERVATION IN SEMIARID REGIONS.
Agricultural Research Service, Akron, CO. Central Great Plains Research Station.
For primary bibliographic entry see Field 4D.
W91-03141

IMPROVED RAINFED FARMING FOR SEMI-ARID TROPICS: IMPLICATIONS FOR SOIL AND WATER CONSERVATION.
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India). Farming Systems Research Program.
For primary bibliographic entry see Field 4D.
W91-03142

CONTROLLING EROSION AND SEDIMENT LOSS ON FURROW-IRRIGATED LAND.
Agricultural Research Service, Kimberly, ID. Snake River Conservation Research Center.
For primary bibliographic entry see Field 4D.
W91-03143

ESTABLISHMENT OF PLANT COVER PARAMETERS FOR MODELLING SPLASH DETACHMENT.
National Coll. of Agricultural Engineering, Silsoe (England).
For primary bibliographic entry see Field 2J.
W91-03145

CONSERVATION TILLAGE: AN IMPORTANT, ADAPTABLE TOOL FOR SOIL AND WATER CONSERVATION.
Soil Conservation Service, Washington, DC.
For primary bibliographic entry see Field 4D.
W91-03171

RESEARCH STRATEGY FOR ASSESSING THE EFFECT OF EROSION ON FUTURE SOIL PRODUCTIVITY IN THE UNITED STATES.
Agricultural Research Service, Tucson, AZ. Southwest Watershed Research Center.
For primary bibliographic entry see Field 4D.
W91-03174

CITANDUY PROJECT IN JAVA: TOWARD A NEW APPROACH TO WATERSHED STABILIZATION AND DEVELOPMENT.
Agency for International Development, Karachi (Pakistan).
For primary bibliographic entry see Field 4D.
W91-03176

MODELLING OF ENERGY FORESTRY: GROWTH, WATER RELATIONS AND ECONOMICS.
For primary bibliographic entry see Field 2I.
W91-03198

INTRODUCTION TO MODELLING OF PLANT WATER CONDITIONS.
Gdansk Technical Univ. (Poland). Inst. of Hyrdotechnics.
For primary bibliographic entry see Field 2I.
W91-03199

ROLE OF DRIP IRRIGATION IN GROUNDWATER MANAGEMENT IN BASALTIC TERRAIN: A CASE STUDY OF SOLAPUR DIST.
D.B.F. Dayanand Coll. of Arts and Science, Sholapur (India).
M. K. Zambre.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 969-978, 2 fig, 1 tab, 6 ref.

Descriptors: *Agricultural water, *Drip irrigation, *Groundwater irrigation, *India, *Irrigation practices, *Water conservation, Basalts, Case studies, Consumptive use, Crop yield, Drought, Performance evaluation, Sugarcane, Vine crops.

The Solapur District of Maharashtra State (India) covers about 15,000 sq km; four of eleven talukas in the district are drought prone. For maximal economic development and food production, groundwater must be used efficiently. Drip irrigation is an efficient method of providing water directly into the soil at the root zone of the plant. With drip irrigation, the water delivery can approximate the consumptive use of the plant. Out of a total cultivable area of 20.8 million hectares, at most 26% comes under a surface irrigation system. By application of groundwater resources, this figure increases to 40%. However, if drip irrigation systems were used then this percentage would increase to 60-70%. Drip irrigation began to be adopted by farmers in Solapur state in early 1986. By the end of 1987, 684 hectares of land came under drip irrigation for cultivation for grapes and sugarcane. Water saving was about 55% with drip irrigation. In South Solapur taluka, the drip system has been used for sugarcane, with a saving of about 60% in groundwater and an increase in production of about 6%. (See also W91-03311) (Rochester-PTT)
W91-03360

EVALUATION OF OPTIMAL CONSTANT-VOLUME CONTROL FOR IRRIGATION CANALS.
Wyoming Univ., Laramie. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 8B.
W91-03413

MATHEMATICAL ZERO-INERTIA MODELING OF SURFACE IRRIGATION: ADVANCE IN BORDERS.
Institut de Mecanique de Grenoble, Saint-Martin d'Heres (France).
G. H. Schmitz, and G. J. Seus.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 5, p 603-615, September/October 1990. 6 fig, 20 ref, append. German Science Foundation (DFG) Grant No. Se 316/7 and Se 316/11.

Descriptors: *Border irrigation, *Drainage engineering, *Infiltration, *Irrigation efficiency, *Irrigation engineering, *Mathematical models, Differ-

ential equations, Furrow irrigation, Hydrodynamics, Momentum equation, Numerical analysis.

The basis for comprehensive analytical models, equations, and their solutions for border or furrow irrigation advance has been derived. This basis consists of an analytical solution of the zero-inertia differential equations, which assumes a moving momentum representative cross-section in the water body. It takes into account the time-varying character of infiltration and does not contain any restrictions on the infiltration formula used. This solution was specifically developed for a zero-inertia model of border irrigation advance (ZIMBA). It proved efficient in three types of application: (1) simulation of irrigation advance in sloping borders; (2) replacement within a numerical model of the cumbersome, but widely used, mass-balance techniques for calculating the flow in the tip region of the wave; and (3) generating initial values for starting a numerical simulation of border irrigation. The results of ZIMBA were compared to observed values and to results of a full hydrodynamic model, with nearly perfect agreement. For the data that were analyzed, the prediction error always remained below 4%. (Author's abstract)
W91-03420

RATIONAL APPROACH FOR MODIFYING ROTATIONAL WATER DELIVERY SCHEDULE.
Central Soil Salinity Research Inst., Karnal (India).
S. Bhirud, N. K. Tyagi, and C. S. Jaiswal.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 5, p 632-644, September/October 1990. 7 fig, 3 tab, 13 ref.

Descriptors: *Crop yield, *Drainage engineering, *Irrigation efficiency, *Irrigation engineering, *Scheduling, *Water conservation, Evapotranspiration, Growth, Simulation analysis, Water delivery, Water demand.

Irrigation scheduling, which anticipates the temporal water need of crops, is an important management activity affecting the performance of irrigation projects. Equally important factors are the water delivery schedule and canal capacity that determine the actual application schedules. An analysis of water delivery schedules was made based on a water-balance simulation approach using a crop growth simulation models. Five rotational schedules of two, three, four, five, and six weeks were compared to an on-demand schedule in terms of evapotranspiration, total water applied, and yield. Simulated yields for on-demand and a two-week rotation schedule are comparable. Longer rotation schedules resulted in yield decreases. Modifying the rotation schedule in critical growth periods saved water and resulted in minimum yield losses. The best modified rotation schedule produced 94% of the on-demand yield. (Author's abstract)
W91-03422

OBSERVABILITY OF SURFACE IRRIGATION ADVANCE.
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
N. D. Katopodes.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 5, p 656-675, September/October 1990. 10 fig, 7 tab, 11 ref. Agricultural Research Service, U.S. Department of Agriculture, Cooperative agreement no. 58-82HW-5-01; National Science Foundation grant no. BCS-8914980.

Descriptors: *Drainage engineering, *Field tests, *Infiltration, *Irrigation efficiency, *Irrigation engineering, *Model studies, *Water conservation, Algorithms, Border irrigation, Computer models, Flow characteristics, Numerical analysis, Resistance, Surface flow.

Computer models for surface irrigation produce results that depend heavily on the field parameters supplied to the models as input. The conditions of observability and field-parameter identifiability for surface irrigation advance were examined by analytical techniques and the linearized zero-inertia model. The existence and uniqueness of the inverse irrigation problem were established by numerical tests based on a nonlinear estimation algorithm. The limitations were examined for determining the field parameters of intake and surface resistance from field-measured values of advance and depth for border-strip irrigation. The linearized zero-inertia model proves to be conditionally observable, and the resistance and two infiltration parameters cannot be identified from measurements of the rate of advance alone. All three parameters on the other hand can be identified from measurements of the surface water profile. The design of appropriate experiments that lead to observability of the problem is difficult because of the physical effects of resistance and infiltration on the dynamics of flow and therefore should be independent of the specific form used to describe these processes. (Author's abstract)
W91-03424

ESTIMATION OF SURFACE IRRIGATION PARAMETERS.
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
N. D. Katopodes, J. H. Tang, and A. J. Clemmens.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 5, p 676-696, September/October 1990. 6 fig, 2 tab, 31 ref. Agricultural Research Service, U.S. Department of Agriculture, Cooperative agreement no. 58-82HW-5-01; National Science Foundation grant no. BCS-8914980.

Descriptors: *Drainage engineering, *Infiltration, *Irrigation engineering, *Mathematical models, *Model studies, *Roughness coefficient, *Surface irrigation, Algorithms, Field tests, Mathematical analysis, Numerical analysis, Parametric hydrology.

During the last 20 years, there have been significant advancements in both the understanding of the physical principles and the mathematical modeling of surface irrigation. Approximations in the mathematical model and lumping of the field parameters are interrelated in a complicated fashion, finally producing what is known as the numerical simulation. The basic concepts and procedures for the estimation of roughness and infiltration parameters encountered in surface irrigation were examined. Conjugate gradient and variable metric techniques were used for the search of the parameter set that minimizes the errors between field observations and the linearized zero-inertia model. Appropriate constraints that restrict the variation of parameters within physically-realistic limits were also imposed on the objective function. The performance and radius of convergence of the search algorithm were studied by numerical tests that demonstrate the steps in the development of the associated objective function and the strategy required for convergence to the correct values of the field parameters. It is concluded that a key role is played by the formulation of the direct problem and its numerical solution, and that the nonlinear field parameter search converges quickly when the influence of independent parameters can be decoupled during construction of the objective function. (Author's abstract)
W91-03425

SELF-ADAPTIVE CONTROL OF SURFACE IRRIGATION ADVANCE.
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
N. D. Katopodes, and J. H. Tang.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 5, p 697-713, September/October 1990. 15 fig, 15 ref. Agricultural Research Service, U.S. Department of Agriculture, Cooperative agreement no. 58-82HW-5-01; National Science Foundation grant no. BCS-8914980.

Descriptors: *Channel inflow, *Drainage engineering, *Irrigation efficiency, *Irrigation engineering, *Numerical analysis, *Surface irrigation, Computer models, Field tests, Flow rates, Infiltration, Mathematical models, Optimization.

Optimization and control of surface irrigation efficiency is a crucial agricultural activity. The controllability of surface irrigation advance was examined by analytical means and numerical tests based on the linearized zero-inertia model. First, the inflow hydrograph was proved to be identifiable from advance data. Then, it was shown that it is possible to control the advance rate by adjustment of the inflow rate. Field parameter heterogeneities are automatically taken into account, so a predetermined advance trajectory is obtained under arbitrary field conditions. The model utilizes a tentative time increment, during which a trial value for inflow is adopted. The resulting wave advance is simulated by the zero-inertia model. Discrepancies between the actual and desired advance rate are then used to construct an objective function, whose minimization leads to a correction of the inflow rate for the next time increment of inflow. Finally, examples of self-adaptive control were studied, in which an irrigation stream was led into a field of unknown parameters. The model uses real-time information for the identification of the parameters and simultaneous control of the inflow rate to achieve a desired advance rate. (Author's abstract)
W91-03426

FURROW INFILTRATION ON NONTILLED BEDS WITH CRACKING SOILS.
Agricultural Research Service, Prosser, WA. Irrigated Agriculture Research and Extension Center.
R. G. Evans, C. J. Smith, P. D. Mitchell, and P. J. Newton.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 5, p 714-733, September/October 1990. 6 fig, 5 tab, 47 ref.

Descriptors: *Australia, *Furrow irrigation, *Infiltration, *Irrigation design, *Irrigation engineering, Beds, Clays, Crops, Flow rates, Infiltrometers, Irrigation programs.

Furrow irrigation techniques are used on approximately 5-10% of the irrigated land in the Murray-Darling Basin of southeastern Australia. A recirculating furrow infiltrometer was used to determine the effect of three flow rates on infiltration for nontilled beds established on a red-brown earth soil (heavy clay soil) in the region. Flow rates were 0.13 L/s (low), 0.38 L/s (medium), and 0.61 L/s (high). Tests were repeated four times at two-week intervals over the irrigation season. Infiltration measurements were made over 10-m-long furrows for a minimum of five hours of outflow. It was found that increasing the flow rate, with commensurate increases in wetted perimeter and depth of water in the furrow, increased the volume infiltrated into the nontilled beds on these soils. Because of this effect, the depth of water in the furrow should be maintained as high as possible without flooding the surface of the beds. Narrow spacing between furrows and the presence of crop residues in the furrow may also be beneficial. The volume infiltrated, calculated from the Kostiakov-Lewis equation, decreases with time during the season and is especially evident at the high flow rate. (Author's abstract)
W91-03427

INTERACTIVE EFFECTS OF SALINITY AND CALCIUM ON HYDRAULIC CONDUCTIVITY, OSMOTIC ADJUSTMENT, AND GROWTH IN PRIMARY ROOTS OF MAIZE SEEDLINGS.
Technion - Israel Inst. of Tech., Haifa. Faculty of Agricultural Engineering.
D. Evlagon, I. Ravina, and P. Neumann.
Israel Journal of Botany IJBOAU, Vol. 39, No. 3, p 239-247, 1990. 4 tab, 22 ref.

Descriptors: *Calcium, *Irrigation design, *Plant growth, *Root development, *Saline soils, *Salinity, Conductivity, Corn, Osmotic pressure, Roots, Temperature effects, Viscosity.

Increasing the calcium ion activity in salinized root media has often been shown to ameliorate the inhibitory effect of salinity on plant growth. In order to better define the biophysical mechanisms involved in these growth responses, the interactive

effects of salinity and calcium on hydraulic conductivities and osmotic potential gradients in roots of maize seedlings were investigated. The length of the primary roots was reduced by 54% after 4 days of growth in 0.1-strength Hoagland solution salinized with 100 mM NaCl and by 20% when 10 mM calcium was also added to the salinized root medium. Roots showed 69% osmotic adjustment in response to salinization, with or without extra calcium in the root medium. The mean hydraulic conductivity, of the apical 4 cm of maize seedling roots was determined by assaying osmotically-induced backflow. The assay was sensitive enough to detect reductions in conductivity induced by lowering the assay temperature from 27 to 14 C. These reductions in conductivity exceeded those caused by temperature-induced changes in the viscosity and density of water alone and presumably reflected changes in cell membrane permeability. Salinization with 100 mM NaCl reduced root hydraulic conductivity by 80% and by 51% when 10 mM calcium was also present. Cell extension growth and hence root growth are related to the hydraulic conductivity of the water uptake pathway; the fact that salinity reduced both conductivity and root growth, while additional calcium partially reversed these reduction, suggests that changes in conductivity may have a role in the complex of events regulating root growth responses to salinity stress. (Author's abstract)
W91-03520

CROPPING STRATEGIES FOR EFFICIENT USE OF WATER AND NITROGEN.
American Society of Agronomy, Inc., Madison, Wisconsin. ASA Special Publication Number 51, 1988. 218p. Edited by W. L Hargrove.

Descriptors: *Agricultural water, *Cropping, *Illinois, *Nitrogen, *Soil-water-plant relationships, *Water use efficiency, Agricultural hydrology, Agriculture, Leaching, Nitrogen fixation, Plant-water relationships.

Water and N are two factors that have a major influence on crop production. Water is provided by rainfall, and where rainfall is insufficient, supplemental irrigation is used. Similarly, N needs can be provided by using legumes and other N2-fixing systems, or supplemented with N fertilizer and manures. Since crop production is at the beginning of most human food chains and is an essential human activity, water and N influence human health, welfare, and economics in critical ways. Therefore, it is important to understand the interaction of water and N in cropping systems, responses to these vital inputs, and ways of managing water and N most efficiently. This book deals with water and N management from several perspectives, including crop species, crop sequences, cultural practices, inputs, and environmental quality. Papers discuss the use of cropping systems to gain N2 fixation and efficiency of utilization of this fixed N. Cropping systems, including rotations, multiple cropping, intercropping and specific cropping systems for low input agriculture as well as using specific cropping systems for reduced leaching of salts are topics included in the papers. (See W91-03634 thru W91-03645) (Lantz-PTT)
W91-03633

CROPPING STRATEGIES FOR EFFICIENT USE OF WATER AND NITROGEN: INTRODUCTION.
Georgia Agricultural Experiment Stations, Griffin.
W. L. Hargrove, A. L. Black, and J. V. Mannering.
IN: Cropping Strategies for Efficient Use of Water and Nitrogen. American Society of Agronomy, Inc., Madison, Wisconsin. ASA Special Publication Number 51, 1988. p 1-5, 2 fig, 1 tab, 10 ref.

Descriptors: *Agricultural water, *Crop production, *Cropping, *Economic aspects, *Illinois, *Nitrogen, *Water use efficiency, Agronomic crops, Crop yield, Erosion, Financing, Pesticides.

Currently, crop production in the USA can be characterized by low commodity prices and relatively high input costs, as well as increasing concern over the influence of modern agriculture on environmental quality. While commodity prices have been dropping, production cost have been increasing. Crop production in the USA is highly mechanized, requiring little labor, but dependent instead on large and specialized equipment, relatively large fossil fuel energy inputs, and intensive fertilizer and pesticide use. Furthermore, over the past few years, producers have incurred a high rate of indebtedness for capital and operating expenditures causing interest paid on borrowed money to become a major expense. In addition, land values have declined dramatically, greatly decreasing the landowners worth and his opportunity to borrow money. The recent decline in prices coupled with the increase in production costs, have resulted in a narrow margin of profitability for most crops. Current crop production has become less diversified. Continuous mono-cropping with little or no crop rotation is questionable economically, as well as ecologically. The lack of diversification leaves the producer vulnerable to disaster at the hands of crop pests (weeds, diseases, and insects). There are growing concerns over groundwater contamination by fertilizers and pesticides. In addition, more than 70 million ha of cropland are eroding at rates greater than the soil loss tolerance, the rate at which sustained production is possible, and 23% of cropland is eroding at twice the tolerable rate. Research has shown increases in NO3-N in groundwater concurrent with major increases in N fertilization. (See also W91-03633) (Lantz-PTT)
W91-03634

MULTIPLE CROPPING FOR EFFICIENT USE OF WATER AND NITROGEN.
Georgia Coastal Plain Experiment Station, Tifton.
J. E. Hook, and G. J. Gascho.
IN: Cropping Strategies for Efficient Use of Water and Nitrogen. American Society of Agronomy, Inc., Madison, Wisconsin. ASA Special Publication Number 51, 1988. p 7-20, 37 ref.

Descriptors: *Agriculture, *Cropping, *Economic aspects, *Illinois, *Nitrogen, *Water use efficiency, Conservation, Crop production, Crop rotation, Erosion control, Nitrogen fixation, Nutrients.

What most farming techniques have in common is their attempt to produce more from a parcel of land than would be obtained from one crop alone. Multiple cropping has been practiced since antiquity; however, the possibility that multiple cropping may increase the productivity of land and make more efficient use of resources has led to a renewed interest in multiple cropping. The possibility of distributing annual fixed costs over more than one crop, changing patterns of cash flow, and reducing risks of total crop failure are some of the economic incentives that have encouraged multiple cropping. Possibilities for reduction in soil erosion, for retention of soluble nutrients, and for minimizing labor needed for minimizing labor needed for land preparation favor planting a second crop, if only a cover crop. Multiple cropping systems are most effective in improving water and N RUE (Resource Use Efficiency) when those systems capture and convert water and N that would otherwise be lost during noncrop periods of monocrop culture. By increasing total production, multiple cropping can reduce the land requirements needed for a given quantity of products. While water and N RUE may be improved by multiple cropping, they also may be decreased. Improvement of N and water RUE through multiple-cropping systems is by itself insufficient justification for establishing multiple-cropping systems. That justification must come from a socioeconomic analysis of the systems. When water and N are underutilized or lost be the practice of one crop per year, the added RUE afforded by multiple cropping suggests that they should be considered in the analysis. (See also W91-03633) (Lantz-PTT)
W91-03635

CROP ROTATION AND ITS IMPACT ON EFFICIENCY OF WATER AND NITROGEN USE.
Michigan State Univ., East Lansing.
F. J. Pierce, and C. W. Rice.
IN: Cropping Strategies for Efficient Use of Water and Nitrogen. American Society of Agronomy, Inc., Madison, Wisconsin. ASA Special Publication Number 51, 1988. p 21-42, 3 fig, 3 tab, 68 ref.

Descriptors: *Agriculture, *Crop rotation, *Illinois, *Nitrogen fixation, *Water use efficiency, Conservation, Cropping, Nitrogen.

Crop rotations have generally been viewed as beneficial, but have not always been viewed as economical. Nitrogen applications can, in many cases, replace the rotation effect as long as supplies remain unrestricted (economically and environmentally). The impact of rotations on N use efficiency (NUE) is shown to be dependent upon the definition of NUE, crop response in rotation to available N, and the time frame of consideration, in other words, the indirect or long-term rotation effects. A true assessment of the crop rotation impact on NUE will only be obtained when all N pools are considered, and not solely through crop response to applied N. Efficient water use (EWU) is a function of water use efficiency (WUE). Many studies show a significant increase in yield or biomass when crops are grown in rotation. Rotations are often considered to improve water relationships in soils. It is generally agreed that as biomass increases, water use increases. The two models proposed here for the relationship between WUE and biomass seem to occur in the field, and indicate that rotations can effect EWU. (See also W91-03633) (Lantz-PTT)
W91-03636

PLANTING GEOMETRIES AND THE EFFICIENT USE OF WATER NUTRIENTS.
Agricultural Research Service, Kimberly, ID.
R. E. Sojka, D. L. Karlen, and E. J. Sadler.
IN: Cropping Strategies for Efficient Use of Water and Nitrogen. American Society of Agronomy, Inc., Madison, Wisconsin. ASA Special Publication Number 51, 1988. p 43-68, 3 fig, 4 tab, 198 ref.

Descriptors: *Agriculture, *Cropping, *Illinois, *Nutrients, *Plant-water relationships, *Soil-water-plant relationships, *Water use efficiency, Conservation, Crop yield, Evapotranspiration, Legumes, Nitrogen fixation.

For a wide range of species it appears that a greater yield advantage may exist for dense, uniformly spaced canopies than for more open canopies, provided early weed management, water availability, and fertility are adequate. This advantage is more pronounced for plants with intermediate growth habits. Manipulation of row-spacing configurations may be the most practical means of optimizing canopy geometry. Leguminous plants may require greater than expected mineral nutrient availability to maximize nodulations and N2 fixation in these denser, management intensive cropping systems. Row spacing and row orientation may effect canopy light quality and soil temperatures sufficiently to alter rhizobial-host interactions and N2 fixation of leguminous plants. The interaction of planting geometry and the nutrient relations of the soil plant system are not well documented. Due to earlier leaf area index (LAI) increases, early season (and often total season) ET (evapotranspiration) are frequently higher in denser canopies. Wider rows of some crops may have higher ET due to sensible heat transfer from dry interrow surface, although there are conflicting data on this point. Plant physiological indices of water stress frequently indicate greater stress in narrow rows or denser canopies, particularly under nonirrigated conditions, probably due to greater early season water depletion. Soil physical and equipment-engineering limitations may impose the ultimate practical and financial barriers to the adoption of high-intensity, dense canopy management systems. (See also W91-03633) (Lantz-PTT)
W91-03637

ROLE OF CROP RESIDUES--IMPROVING WATER CONSERVATION AND USE.
Agricultural Research Service, Bushland, TX.
P. W. Unger, G. W. Langdale, and R. I. Papendick.
IN: Cropping Strategies for Efficient Use of Water and Nitrogen. American Society of Agronomy, Inc., Madison, Wisconsin. ASA Special Publica-

tion Number 51, 1988. p 69-100, 1 fig, 16 tab, 121 ref.

Descriptors: *Agricultural water, *Conservation tillage, *Illinois, *Water conservation, *Water use, *Water use efficiency, Agriculture, Conservation, Evapotranspiration, Plant-water relationships, Tillage.

Crop residue management or conservation tillage systems are widely recognized for their soil conservation benefits. They also effectively conserve water in many situations. However, much of the water that potentially could be conserved and used for crop production still is lost through runoff, evaporation, or transpiration by noncrop plants. Examples of more effective and adaptable conservation tillage systems are: (1) More effective herbicides--highly effective and specific herbicides are needed to control weeds and volunteer crop plants; (2) Improved equipment--vast improvements in equipment capable of operation under high residue conditions have been made in recent years. The improved equipment should provide trouble free operations, provide effective separation between seeds and residues, cause minimum destruction of surface residues, and place seeds at uniform depth; (3) Improved residue maintenance--crop residues often are limited and subject to decay; (4) Improved cropping sequences--research is needed to develop cropping sequences that result in more effective timing among periods of soil water shortage, water availability, and crop growing seasons; and (5) An improved understanding of basic soil-water-plant relationships. (See also W91-03633) (Lantz-PTT)
W91-03638

ROLE OF CROP RESIDUE MANAGEMENT IN NITROGEN CYCLING USE.
Agricultural Research Service, Lincoln, NE.
For primary bibliographic entry see Field 3F.
W91-03639

ROLE OF CROP RESIDUE MANAGEMENT IN NITROGEN CYCLING USE.
Agricultural Research Service, Lincoln, NE.
J. F. Power, and J. W. Doran.
IN: Cropping Strategies for Efficient Use of Water and Nitrogen. American Society of Agronomy, Inc., Madison, Wisconsin. ASA Special Publication Number 51, 1988. p 101-113, 7 tab, 43 ref.

Descriptors: *Agriculture, *Crop production, *Cycling nutrients, *Illinois, *Nitrogen cycle, *Soil properties, Evaporation, Fertilizers, Resources management, Tillage.

Crop residue management alters the soil environment, thereby influencing microbiological populations and activity in soil and subsequent N transformations. It is through this change of events that crop residue management affects the efficiency with which fertilizers, water and other resources are used in cropping systems. In spite of the complexities involved, a few generalized conclusions regarding crop residue management are possible. First, leaving crop residue on the soil surface reduces evaporation rate, thereby maintaining soil water regimes that are more favorable for microbiological activity over longer periods of time. Another consequence is that of enhanced size and duration of the soil microbial mass, and greater quantities of N temporarily immobilized in the biomass. Research suggests that under certain environmental conditions, the N immobilized in microbial biomass is a primary source of the N mineralized and made available to crops during the growing season. There are several other methods by which crop residue management may effect N cycling and efficiency of use, such as reduced losses of soil organic nitrogen through soil erosion, thereby maintaining organic nitrogen pool sizes and turnover rates. (See also W91-03633) (Lantz-PTT)
W91-03639

ROLE OF NONLEGUMINOUS COVER CROPS IN THE EFFICIENT USE OF WATER AND NITROGEN.
North Carolina State Univ., Raleigh.
M. G. Wagger, and D. B. Mengel.
IN: Cropping Strategies for Efficient Use of Water and Nitrogen. American Society of Agronomy, Inc., Madison, Wisconsin. ASA Special Publication Number 51, 1988. p 115-127, 6 tab, 39 ref.

Descriptors: *Cover crops, *Illinois, *Nitrogen, *Vegetation effects, *Water use efficiency, Agricultural water, Agriculture, Barley, Grain crops, Nitrogen fixation, Nutrients, Oats, Rye, Water use, Wheat.

The importance of nonleguminous cover crops in soil erosion control and the enhancement of soil productivity via organic matter maintenance or even buildup, has long been recognized in agriculture. Commonly used nonleguminous cover crops are the small grains, and include: rye, wheat, oats and barley. In some areas, perennial sod and annual forage crops have been used to provide a vegetative cover. The components of a nonleguminous cover crop management system may offer a complex set of interrelated factors that affect plant growth and development, and hence, crop yield. Nonleguminous cover crops offer the opportunity to enhance N-use efficiency, conserve soil and water, and preserve water quality by acting as sink for residual N that might otherwise leave the soil system. This would also preserve an N resource for use by subsequent crops. Research needs include: (1) a definition of the effects of cover crops on runoff, infiltration, and water storage; (2) clarification of the role of cover crops as sinks for residual N (to include long-term effects on soil organic carbon and nitrogen levels; and (3) a better understanding of N-fertilizer management in cover crop systems to maximize N-use efficiency. (See also W91-03633) (Lantz-PTT)
W91-03640

ROLE OF ANNUAL LEGUME COVER CROPS IN EFFICIENT USE OF WATER AND NITROGEN.
Kentucky Univ., Lexington.
W. W. Frye, R. L. Blevins, M. S. Smith, S. J. Corak, and J. J. Varco.
IN: Cropping Strategies for Efficient Use of Water and Nitrogen. American Society of Agronomy, Inc., Madison, Wisconsin. ASA Special Publication Number 51, 1988. p 129-154, 2 fig, 14 tab, 49 ref.

Descriptors: *Agricultural water, *Cropping, *Illinois, *Legumes, *Nitrogen, *Water use efficiency, Clovers, Mulching, Nitrogen fixation, Vegetation effects, Vetch, Water conservation, Water use.

Annual legume winter cover crops can conserve water and supply a substantial part of the N needed for optimum yields of nonleguminous summer crops. Several legume species are adaptable in such cropping strategies, but hairy vetch appears to perform best in the midsection of the USA from Delaware, Maryland and Kentucky, to Nebraska, while crimson clover as well as hairy vetch appears to be well adapted to the southern part of the Southeast. Cover crops can be established by surface inter-seeding into a summer crop just before leaf drop, or they can be planted after a summer crop has been harvested. A cover crop may be plowed under as a green manure or chemically killed to form a mulch for no-tillage or another form of no-tillage. Plowing the legume under enhances N recovery by the summer crop, but killing it for a surface mulch enhances its soil and water conservation value. Benefits from a legume winter cover crop include: (1) Provides biologically fixed N to succeeding summer crops; (2) Increases soil organic carbon and organic nitrogen relative to winter fallow; (3) Improves soil structure, increases water filtration, decreases runoff, and decreases evaporation losses of water if left as a surface mulch; and (4) Increases soil productivity. The two most important liabilities of using legume winter cover crops are depletion of stored soil water in the early spring and the cost of seeding. (See also W91-03633) (Lantz-PTT)
W91-03641

EXPLOITING FORAGE LEGUMES FOR NITROGEN CONTRIBUTION IN CROPPING SYSTEMS.
Michigan State Univ., East Lansing.
O. B. Hesterman.
IN: Cropping Strategies for Efficient Use of Water and Nitrogen. American Society of Agronomy, Inc., Madison, Wisconsin. ASA Special Publication Number 51, 1988. p 155-165, 1 fig, 10 tab, 34 ref.

Descriptors: *Agriculture, *Cropping, *Illinois, *Legumes, *Nitrogen fixation, Corn, Cycling nutrients, Fertilizers, Nitrogen, Nutrients, Research priorities, Vegetation effects.

Most cropping systems have been found to benefit from the inclusion of a forage legume, with corn yield increases averaging between 38% and 152% from the different cropping strategies. When N fertilizer was used, only the conventional rotations consistently demonstrated a positive corn yield response to the legume. Overseeding may hold potential for exploiting the contribution of legume N, but more research with this system is needed. Unless N fertilizer is not available, interseeding systems do not show promise. Farmers have been exploiting forage legumes for N contribution in cropping systems for many centuries. Scientists have recently been able to quantify these N contributions using various methods, some with more accuracy and success than others. The potential for further exploitation of forage legumes for N contributions is great, however, to exploit these legumes both scientists and farmers need to know more about legume species other than those few that researchers have tested to this point. More knowledge is needed about the interactions of legumes in the systems with different methods of tillage, with different pest problems, and with different pest-control strategies. Finally, and perhaps most importantly in terms of adopting these systems on a large scale, more must be known about the economics of legume N compared with the economics of N from synthetic fertilizer sources under various fertilizer costs and commodity price situations. Only when it can be demonstrated that cropping systems that utilize legume N are more profitable will these systems become commonplace. (See also W91-03633) (Lantz-PTT)
W91-03642

ROLE OF CROPPING SYSTEMS IN ENVIRONMENTAL QUALITY: GROUNDWATER NITROGEN.
Agricultural Research Service, Lincoln, NE.
J. S. Schepers.
IN: Cropping Strategies for Efficient Use of Water and Nitrogen. American Society of Agronomy, Inc., Madison, Wisconsin. ASA Special Publication Number 51, 1988. p 167-178, 4 fig, 1 tab, 15 ref.

Descriptors: *Cropping, *Environmental protection, *Groundwater quality, *Illinois, *Nitrogen, *Nonpoint pollution sources, *Water pollution sources, Crop production, Groundwater pollution, Leaching, Nitrates.

Leaching of NO3 to groundwater occurs when the water content of soil exceeds the soil's ability to retain the water. Nitrate is known to leach through the soils and into groundwater within a matter of days in some cases, while it may require many years in other ecosystems. Because of the dynamics of N and water, an annual budget of each may not be appropriate and therefore cropping systems of the future may be sensitive to all aspects of the hydrologic and N cycling on a short-term and long-term basis. The potential for NO3 leaching may be accelerated because of variations in monthly precipitation patterns, especially if no crop is growing. Both high intensity rainfall and above average amounts of precipitation increase the potential for N losses via runoff and leaching. Society is becoming frustrated with reports of NO3 contamination of groundwater and what may appear as a lack of remedial measures on the part of producers. Agriculture must assume a major portion of the responsibility for the problem, and is therefore expected to make a concerted effort to

remedy the situation. (See also W91-03633) (Lantz-PTT)
W91-03643

ROLE OF CROPPING SYSTEMS IN ENVIRONMENTAL QUALITY: SALINE SEEP CONTROL.
Agricultural Research Service, Akron, CO.
A. D. Halvorson.
IN: Cropping Strategies for Efficient Use of Water and Nitrogen. American Society of Agronomy, Inc., Madison, Wisconsin. ASA Special Publication Number 51, 1988. p 179-191, 3 fig, 4 tab, 51 ref.

Descriptors: *Cropping, *Environmental protection, *Illinois, *Saline water intrusion, *Soil-water-plant relationships, *Water conservation, *Water use, Agriculture, Plant-water relationships, Soil water, Water use efficiency.

Saline seeps are caused by a combination of geologic, climatic, and cultural conditions. The term saline seep describes a salinization process accelerated by dryland farming practices that utilize water inefficiently, allowing water to move through salt laden substrata below the root zone. Saline seep is accepted to mean intermittent or continuous saline water discharge, at or near the soil surface down-slope from recharged areas under dryland conditions. If more intensive cropping systems than the conventional crop fallow are to be successful in the dryland saline seep areas of the Great Plains, farmers need to know: the soil water status for planting, an estimate of growing season precipitation, crop rooting depths and soil-water use characteristics, soil fertility, weed and pest control practices, water conservation strategies, yield and disease characteristics of crop varieties, crop rotations, and other soil and crop management factors. Timely farm operations will be essential along with soil-test information and a knowledge of the depth of impermeable geologic strata and water tables to make a flexible, intensive crop management system work. (See also W91-03633) (Lantz-PTT)
W91-03644

LOW-INPUT CROPPING SYSTEMS AND EFFICIENCY OF WATER AND NITROGEN USE.
Agricultural Research Service, Kutztown, PA.
J. K. Radke, R. W. Andrews, R. R. Janke, and S. E. Peters.
IN: Cropping Strategies for Efficient Use of Water and Nitrogen. American Society of Agronomy, Inc., Madison, Wisconsin. ASA Special Publication Number 51, 1988. p 193-218, 6 fig, 4 tab, 52 ref.

Descriptors: *Agriculture, *Cropping, *Illinois, *Nitrogen, *Water use efficiency, Nitrogen fixation, Nutrients, Soil properties, Water conservation, Water use.

In recent years there has been an increasing concern with modern, intensive farming methods, which rely heavily on pesticides and chemical fertilizers. The concept of N-use efficiency needs to be modified to be useful in evaluating low-input (LIP) systems that rely on legume and animal manure sources of N. Realistic estimates of N availability and loss in these systems will probably involve complicated N budgets that take into account the slow release of organic sources of N, transformations of N in the soil, and cycling processes that involve soil micro-fauna and macro-fauna. Intensified N cycling through an increase in soil biological activity in low-input systems may also contribute to greater N use efficiency over the long-term. Results of a Rodale cropping systems study reveal that: (1) Efficiency of N use is increased by starting an LIP rotation with crops that demand less N than corn; (2) Multiple cropping is an efficient way to establish green manure crops without sacrificing cash crop production, and looks promising for increasing economic returns from low-input cash grain (LIP-CG) systems by allowing for more intensive crop rotations; and (3) To provide good crop yields and high net returns, careful management and planning of LIP cropping systems is essential. A balanced cropping rotation is needed to assure adequate internal resources, including N, water, and weed control. (See also W91-03633) (Lantz-PTT)
W91-03645

TANK IRRIGATION IN SEMI-ARID TROPICAL INDIA: ECONOMIC EVALUATION AND ALTERNATIVES FOR IMPROVEMENT.
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).
W. von Oppen, and K. V. Subba Rao.
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh India. Research Bulletin No. 10, 1987. 38p, 10 fig, 17 tab, 29 ref, append.

Descriptors: *India, *Irrigation practices, *Semi-arid lands, *Tank irrigation, *Tropical regions, *Water conservation, *Water resources management, Agriculture, Developing countries, Economic aspects, Irrigation, Simulation analysis, Storage tanks, Water resources development.

A survey of 32 tanks and farm data from Andhra Pradesh and Maharashtra states was used to assess the economic performance of irrigation tanks in the semi-arid tropics in India. District data on climatic and Institutional variables were used to analyze the factors affecting tank irrigation density. Results indicate that the spatial distribution of irrigation tanks is determined primarily by physical factors--hard rock substratum, postmonsoon rains, low moisture holding capacity of soils--and by population density. Tank irrigation, formerly a source of relative stability, has become a source of instability for agricultural production in many parts of India. Important factors for the decline in tank irrigation are: environmental degradation such as deforestation, soil erosion, siltation, tank bed cultivation, and lack of administrative setup to provide timely repair and maintenance of tanks, and to ensure proper water control and tank management. Simulation results show that with improved water control and by keeping sluices closed on rainy days, a 20% larger command area can be irrigated. A Tank Irrigation Authority is proposed for better water control and management. Another concept proposed is Composite Watershed Management on Alfisols involving a system of runoff and erosion controlling land management for enhanced groundwater recharge and sustained well irrigation. This concept, analyzed at ICRISAT Center in a modeling exercise, has considerable economic potential. (Author's abstract)
W91-03648

WASTEWATER IRRIGATION IN DEVELOPING COUNTRIES: HEALTH EFFECTS AND TECHNICAL SOLUTIONS.
Hebrew Univ. of Jerusalem (Israel). School of Public Health.
H. I. Shuval, A. Adin, B. Fattal, E. Rawitz, and P. Yekutiel.
The World Bank, Washington, DC. World Bank Technical Paper No. 51, 1986. 324p, 70 fig, 53 tab, 216 ref.

Descriptors: *Developing countries, *Irrigation water, *Public health, *Wastewater irrigation, *Wastewater treatment, Bacteria, Economic aspects, Epidemiology, Fecal coliforms, Helminths, Human diseases, Irrigation practices, Model studies, Pathogens, Viruses, Water pollution effects.

Wastewater reuse for agriculture in developing and developed countries is summarized. The potential health effects from such reuse are evaluated, and effective and economic methods of control are proposed that are particularly suited to developing countries. A theoretical model was developed, based on a review of available credible epidemiological studies and reports, to assist in predicting the degree of risk of disease transmission associated with various wastewater reuse practices. The empirical evidence and the model suggest that the highest risk of pathogen transmission, infection, and sickness is associated with the helminths, followed in order by bacterial infections and last by viral infections. The model provides a basis for evaluating control options. Although certain health risks are clearly associated with the use of raw wastewater in agriculture, the epidemiological evidence assembled for this study also suggests that the very stringent wastewater irrigation standards developed in many of the industrialized countries are overly restrictive. The study suggests a guideline for unrestricted wastewater irrigation based on an effluent with less than one nematode egg (Ascaris or Trichuris) per liter and a geometric mean fecal coliform concentration of 1,000/100 mL. Technological and policy options for reducing and controlling any health risks of wastewater reuse in agriculture are evaluated. In particular, multicell stabilization ponds with 20 days' detention time effectively remove bacterial, viral, and helminth pathogens in a low-cost, robust, easy-to-operate system that is especially suitable for developing countries. Appropriate wastewater treatment in combination with controlled irrigation techniques and restrictive cropping practices represent effective remedial measures. (Author's abstract)
W91-03650

EFFICIENT USE OF WATER IN IRRIGATION: PRINCIPLES AND PRACTICES FOR IMPROVING IRRIGATION IN ARID AND SEMIARID REGIONS.
Massachusetts Univ., Amherst. Dept. of Plant and Soil Sciences.
D. Hillel.
The World Bank, Washington, DC. World Bank Technical Paper No. 64, 1988. 107p, 42 fig, 7 tab, 102 ref.

Descriptors: *Arid lands, *Developing countries, *Irrigation efficiency, *Semiarid lands, *Water conservation, *Water use, Agriculture, Irrigation practices, Irrigation water, Salinity, Social aspects, Water resources management.

A basic review and analysis is provided concerning the principles governing soil-crop-water-climate relationships, irrigation, and the efficient utilization of water in arid and semiarid regions. It presents a critique of traditional and current irrigation concepts and practices, pointing out the needs and potentialities for improving the efficiency of land and water use in developing countries. Starting from a basic analysis of the environmental, physiological, and agronomic factors affecting irrigation, historical approaches to management are contrasted with modern approaches. Methods are described for scheduling irrigation and measuring irrigation water; these are then compared with alternative irrigation systems, along with the specific requirements and methods of drainage and salinity control. Finally, there is a discussion about some of the human consideration involved in the vital task of developing sound, appropriate, and sustainable irrigation systems. (Lantz-PTT)
W91-03651

LAND HUSBANDRY: A FRAMEWORK FOR SOIL AND WATER CONSERVATION.
For primary bibliographic entry see Field 4D.
W91-03652

MANAGING CANAL IRRIGATION: PRACTICAL ANALYSIS FROM SOUTH ASIA.
Sussex Univ., Brighton (England). Inst. of Development Studies.
R. Chambers.
Cambridge University Press, New York. 1988. 279p.

Descriptors: *Developing countries, *Irrigation canals, *Irrigation management, *Water resources management, Canal linings, Economic aspects, Evaluation, Irrigation efficiency, Irrigation practices.

The many billions of dollars invested in canal irrigation in recent decades have had disappointing results. Rarely have projected benefits in well-being or production been achieved. In consequence, in the mid-1980s, further vast sums are being spent throughout the Third World on programs for rehabilitation, canal lining, on farm development, and farmers' organization. Much of this policy and practice is based on misleading research

and misdiagnosis. When applied to the complexity and uniqueness of canal irrigation systems, the normal professionalism of civil and agricultural engineers, agronomists, economists, and sociologists, leaves gaps which are keys to better performance. In successive chapters, five such gaps are analyzed and presented: main system management, including the scheduling and delivery of water, and communications; canal irrigation at night; management of canal systems jointly by farmers and officials; professional conditions and incentives for irrigation managers; and methods for diagnostic analysis to identify cost-effective actions for improvement. (Lantz-PTT)
W91-03655

ECONOMIC IMPLICATIONS OF THE FOOD SECURITY ACT OF 1985'S DISCRETIONARY ENVIRONMENTAL PROVISIONS.
Economic Research Service, Washington, DC.
For primary bibliographic entry see Field 6E.
W91-03710

WATER QUALITY AND THE CONSERVATION RESERVE PROGRAM: IMPLICATIONS OF TARGETING SALINE CROPLANDS.
Economic Research Service, Washington, DC.
For primary bibliographic entry see Field 5G.
W91-03732

IRRIGATION RECHARGE.
Rural Water Commission of Victoria, Armidale (Australia).
W. Trewhella.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 187-194, 1990. 3 fig, 6 tab, 10 ref.

Descriptors: *Australia, *Groundwater recharge, *Irrigation effects, *Irrigation practices, *Recharge, Geohydrology, Groundwater budget, Irrigation programs, Murray-Darling River Basin, Regional planning, Subsoil drainage, Tile drainage.

Irrigation has dramatically changed the water budget of many areas in the Murray Basin in southeastern Australia. There is a need for a clear understanding of how recharge data have been obtained and used, clearly identifing the aquifer which is being recharged, and specifying appropriate time and space scales. Available data are considered adequate for establishing regional priorities for action to reduce recharge. However, site-specific data are required for the design of projects at the local or sub-regional scale. Monitoring of system performance during and after implementation is necessary to verify the accuracy of data used. Recharge in the Mallee zone is very high, and significant reductions can readily be achieved. Many irrigated areas in the Mallee zone are already tile-drained, so the main benefits of recharge reduction will be lower regional water tables and reduced groundwater discharge to the River Murray. Recharge rates in the Riverine Plains zone are generally much lower, although some areas of high recharge do occur. Options for recharge reduction are identified for use in appropriate circumstances, but residual recharge rates are likely to exceed the safe discharge capacity of the underlying aquifers. Subsurface drainage of the more intensively irrigated areas will be required (as in the Mallee zone), to avoid significant losses of production and land degradation. (Author's abstract)
W91-03892

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

BASIN CHARACTERISTICS, HISTORY OF STREAM GAGING, AND STATISTICAL SUMMARY OF SELECTED STREAMFLOW RECORDS FOR THE RAPID CREEK BASIN, WESTERN SOUTH DAKOTA.
Geological Survey, Rapid City, SD. Water Resources Div.
For primary bibliographic entry see Field 2E.
W91-02968

TECHNIQUES FOR ESTIMATING FLOOD-PEAK DISCHARGES OF RURAL, UNREGULATED STREAMS IN OHIO.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 2E.
W91-02972

FLOOD OF DECEMBER 1987 IN CENTRAL AND EASTERN ARKANSAS.
Geological Survey, Little Rock, AR. Water Resources Div.
B. L. Neely.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4188, 1990. 16p, 9 fig, 4 ref.

Descriptors: *Flood discharge, *Flood frequency, *Flood hydrographs, *Flood profiles, *Rainfall, *Rainfall intensity, Arkansas.

Heavy rain fell across Arkansas during December 24-28, 1987. During this period, 6 to 12 inches of rain fell in a 100-mile wide belt extending roughly from Texarkana to West Memphis, Arkansas. The intense rainfall produced flooding throughout much of central and eastern Arkansas. Peak discharges associated with the flood had recurrence intervals of 100 years at two gaging stations. Peak stages, discharges, and recurrence intervals for this flood are documented profiles for 41 gaging stations. Also included in this report are flood profiles for Bayou Meto, Bayou Two Prairie, Cache River, L'Anguille River, and flood hydrographs for gaging stations on Bayou Meto near Lonoke and Cache River at Patterson. (USGS)
W91-02978

WATER RESOURCES OF THE ELK RIVER BASIN, WEST VIRGINIA.
West Virginia Dept. of Natural Resources, Charleston. Div. of Water Resources.
For primary bibliographic entry see Field 2E.
W91-02982

NOGALES WASH AND TRIBUTARIES. FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT.
Army Engineer District, Los Angeles, CA.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A209 732. Price codes: A16 in paper copy, A01 in microfiche. September 1988. 380p, 28 fig, 28 tab, 8 plates, 3 append.

Descriptors: *Flood control, *Floods, *Nogales Creek, *Potrero Creek, *Project planning, Arizona, Cost-benefit analysis, Costs, Flood channels, Flood protection, Flood rating, Mexico.

Nogales and Potrero Creeks have suffered major damage from recent floods. A wide array of flood protection measures are considered in this report, including non-structural and structural alternatives and a no-action plan. Studies have considered flood protection and other water resource measures along the entire Nogales Wash/Potrero Creek watercourse from the International Boundary to the Santa Cruz River. One recommended plan provides for channel improvements at two locations. The first is the 'lateral collector channel' located on the US side of the International Boundary, which would capture overland flow emanating from Mexico. The second channel system located at Chula Vista would capture breakouts from the Nogales and Potrero Creeks and carry the flood flows around the community to a new 3300 foot long grouted stone/concrete channel. The total first cost of the project was estimated at $6,162,000. Annual operation and maintenance is estimated at $11,200. (Lantz-PTT)
W91-03030

C AND SF PROJECT: ADAPTING A WATER RESOURCES PROJECT TO CHANGING PRIORITIES.
Army Engineer District, Jacksonville, FL.
For primary bibliographic entry see Field 6B.
W91-03035

METHOD FOR COMPUTING SHEETFLOW RUNOFF FOR FLAT SLOPES.
South Florida Water Management District, West Palm Beach. Dept. of Resource Management.
For primary bibliographic entry see Field 7B.
W91-03065

EVALUATING THE IMPLEMENTATION AND EFFECTIVENESS OF BASIN PLANS IN KING COUNTY, WASHINGTON.
King County Surface Water Management Div., Seattle, WA.
For primary bibliographic entry see Field 6B.
W91-03093

SOUTHWEST FLORIDA MANAGEMENT DISTRICT SAVE OUR RIVERS PROGRAM.
W. M. Helfferich.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 14B-49--14B-55, 1 fig, 4 ref.

Descriptors: *Environmental protection, *Florida, *Save Our Rivers Program, *Southwest Florida Water Management District, *Surface water, *Water quality, *Water resources management, Big Pine Keys, Bird Rookery Swamp, Kissimmee River, Land use, Water conservation, Wetlands.

Florida's Water Management Lands Trust Fund, commonly known as the Save Our Rivers (SOR) Fund, provides monies to the state's five water management districts for the acquisition and management of lands necessary for water management, water supply and conservation, and protection of water resources. Formed by the legislature in 1981, the SOR program is funded by documentary tax stamps levied on all real estate transactions. The SOR program allows entire drainage systems to be put in public ownership. The South Florida Water Management District (SFWMD) has undertaken an active program to identify and prioritize those lands within the district which meet the criteria for acquisition. An evaluation matrix was developed which allows an objective analysis to be made of each parcel's water management and environmental values. Acquisition efforts are continuing along the Kissimmee River and in the water conservation areas. New acquisition areas include Bird Rookery Swamp in Lee and Collier Counties and the freshwater wetlands of Big Pine Keys. As acquisitions become complete more effort is being placed on long-term management and restoration. Where possible, historic drainage patterns should be reestablished. Efforts are underway to conduct a hydrologic restoration of the 22,000 acre DuPuis Reserve, as well as the more nationally known Kissimmee River Restoration. (See also W91-03032) (Lantz-PTT)
W91-03096

SPECIAL FLOOD HAZARD EVALUATION REPORT: CANASERAGA CREEK, TOWN OF GROVE, ALLEGANY COUNTY, NEW YORK.
Army Engineer District, Buffalo, NY.
For primary bibliographic entry see Field 6F.
W91-03225

GENERALIZED MODEL OF THE REQUIRED STORAGE CAPACITY.
Sarajevo Univ. (Yugoslavia). Inst. of Water Resources Engineering.
H. Hrelja, and D. Isailovic.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 153-167, September 1990. 13 fig, 1 tab, 11 ref.

Descriptors: *Model studies, *Project planning, *Reservoir capacity, *Reservoir design, *Reservoirs, *Storage capacity, *Storage requirements, Economic life, Hydrologic data, Input-output analysis, Water deficit, Water demand.

The required reservoir capacity is defined as the maximum deficit of the net reservoir input. Its size is obviously highly dependent on the input-output characteristics. Total storage is divided into two parts: (1) the stochastic storage associated with the stochastic component of an input series; and (2) the difference storage resulting from that part of input which can be considered as deterministic (periodic). An attempt was made to describe the general behavior of these storages for the regulation of partial flow. To do this, the required reservoir capacity was related to the input series length (i.e. length of expected economic life of a reservoir) and other important parameters of the inflow series. The analyses were based on the generated monthly inflow series from which the mean maximum deficit was estimated. Output series were also represented by the monthly values, and were assumed to be deterministic, either constant or periodic. It has been shown that total storage capacity for partial flow regulation can be linearly related to the product of the mean monthly standard deviation of the input series and the logarithm of the length of these series. (Author's abstract)
W91-03546

GREAT LAKES WATER LEVELS, PAST, PRESENT, AND FUTURE.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 2H.
W91-03681

AESTHETIC IMPLEMENTATION OF NON-POINT SOURCE CONTROLS.
Camp, Dresser and McKee, Inc., Cincinnati, OH.
For primary bibliographic entry see Field 5G.
W91-03728

STORM WATER MANAGEMENT MODEL FOR URBAN AREAS IN KUWAIT.
Kuwait Univ., Safat. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W91-03852

4B. Groundwater Management

HYDROGEOLOGY AND WATER RESOURCES OF THE LOS OSOS VALLEY GROUNDWATER BASIN, SAN LUIS OBISPO COUNTY.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-02971

SIMULATION OF GROUND-WATER FLOW IN THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER IN EASTERN ARKANSAS.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-02976

WATER USE REGULATION FOR THE '90'S - THE SOUTHWEST FLORIDA EXPERIENCE.
Southwest Florida Water Management District, Brooksville. Resource Regulation Dept.
For primary bibliographic entry see Field 6D.
W91-03052

MANAGING GROUNDWATER IN TEXAS: THE CHANGING PACE OF REGULATION.
Texas Tech Univ., Lubbock. Dept. of Geography.
O. W. Templer.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 4B-7--4B-16, 1 fig, 27 ref.

Descriptors: *Groundwater management, *Legal aspects, *Regulations, *Texas, *Water management, *Water resources management, Competing use, Groundwater quality, Groundwater recharge, Groundwater resources, Overdraft, Saline water intrusion, Water demand.

Texas has experienced a gradual decrease in groundwater use in recent years, due in part to new surface water development, various economic factors, and the gradual depletion of some nonrenewable aquifers. However, underground water still accounts for the bulk of water use, and it remains a vitally important resource, especially in arid and semiarid west Texas. Texas courts have adopted the rule that percolating groundwater is the property of the overlying landowner. This doctrine, with only minor modifications, remains in effect today, making Texas unique among the western states in adherence to the strict common law doctrine. Three diverse types of management problems caused by excessive groundwater pumping, each affecting different areas of the state, are: (1) surface subsidence and salt water intrusion; (2) depletion of some nonrenewable aquifers; and (3) reduction of interrelated springflow and streamflow. The first problem pertains primarily to the upper Gulf Coast of Texas, particularly in the area around Houston. The second problem is most generally associated with the extensive Ogallala aquifer of the Texas High Plains. The third problem area is best exemplified by the unique Edwards Limestone aquifer of the Balcones Fault Zone in South Central Texas. This is unquestionably the state's most complex and controversial groundwater problem area, and indications of the future evolution of Texas groundwater law are most apparent here. Since early in this century there have been repeated demands for more stringent groundwater control to prevent overdrafting and encourage conservation. Recently, the pace of regulation has begun to accelerate, as evidenced by several new groundwater management provisions contained in comprehensive water legislation passed in 1985. Still, several areas of Texas are faced with pressing groundwater problems. Their eventual solution will inevitably result in greater regulation, at least for application to these local areas. (See also W91-03032) (Author's abstract)
W91-03053

STATE AND LOCAL GROUND-WATER PROGRAMS RELATED TO WELLHEAD PROTECTION.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
R. M. Lew, and S. P. Roy.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 8B-3--8B-14, 2 fig, 1 tab, 6 ref.

Descriptors: *Groundwater pollution, *Local governments, *State jurisdiction, *Water quality control, *Wellhead protection, Groundwater recharge, Legislation, Public waters, Water pollution control, Water quality management.

Under the Safe Drinking Water Act (SDWA), Section 1428, each State must prepare a Wellhead Protection (WHP) Program and submit it to EPA by June 19, 1989. The purpose of the program is to protect the recharge areas of public water supplies from sources of contamination. Although not a new concept, development and implementation of State and local activities related to Wellhead Protection are now proliferating across the country. Twenty-one states are currently planning to submit a program by the statutory deadline; others have chosen not to for various reasons including a lack of funding. A comparison of WHP activities and groundwater protection legislation (enacted from 1985 to 1987) in states planning to submit a program by the deadline, versus states not planning to submit, shows greater activity and legislation in states planning to submit a program. Wellhead Protection programs as targeted components of a comprehensive groundwater protection strategy can provide the organization and focus necessary to effectively protect public water supplies. Despite a lack of Federal funds, states and regional agencies, along with local communities, are actively attempting to protect public water supply wells from sources of contamination. (See also W91-03032) (Lantz-PTT)
W91-03070

STATISTICAL-BASED METHODOLOGY FOR PRIORITIZING THE VULNERABILITY OF COMMUNITY GROUND-WATER SUPPLIES TO CONTAMINATION.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 5B.
W91-03071

NONTRIBUTARY GROUND WATER AS A MUNICIPAL SUPPLY IN THE DENVER METROPOLITAN AREA.
Denver Water Dept., CO.
J. McCurdy, D. Little, and C. Schuyler-Rossie.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 11B-19--11B-28, 2 fig, 1 tab, 6 ref.

Descriptors: *Denver, *Groundwater management, *Legislation, *Municipal water, *Water resources management, *Water supply development, Aquifers, Artificial recharge, Case studies, Regulations, Water supply.

In 1985, the Colorado legislature established a law (Senate Bill No. 5) to regulate the use of nontributary groundwater. Nontributary groundwater is defined by the law as that water which when withdrawn from the ground will not significantly deplete the surface water system within 100 years. The allowed rate of use of the groundwater supply assumes a 100 year aquifer life. The right to appropriate groundwater in nontributary aquifers is tied to overlying land ownership. However, a condition in the law allows municipal entities to appropriate nontributary groundwater in aquifers underlying their boundaries by the implied consent of landowners. Although there is a vast supply of nontributary groundwater available on a regional basis, many Denver municipal entities cannot rely on a finite resource to meet future demands. A case study was conducted in the Denver Metropolitan Water Supply Environmental Impact Analysis to see how nontributary groundwater could be used as a primary source to meet demands of the Denver Metropolitan area from 1985-2035. Sound planning dictates that the use of nontributary groundwater must be pursued in a conservative manner. Innovative methods to extend the useful life of these supplies, such as integrated use and artificial recharge, should be further pursued and thoroughly researched. (See also W91-03032) (Lantz-PTT)
W91-03086

DROUGHT MANAGEMENT PLAN: MANAGING AND PROTECTING A RESOURCE.
Camp, Dresser and McKee, Inc., Austin, TX.
S. L. Mays, C. A. Teinert, P. W. Glass, and T. P. Fox.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 12B-11--12B-25, 4 tab.

Descriptors: *Drought, *Edwards Aquifer, *Groundwater management, *Texas, *Water resources management, Economic aspects, Public health, Public participation, Water conservation, Water deficit, Water demand.

The Edwards Underground Water District (EUWD) was authorized by H.B. 1942 to develop, implement and enforce a drought management plan (DMP) for the Edwards Aquifer within the boundaries of the District. Certain goals and principles developed during a public hearing process were carried into the planning process. Some of these goals were to: protect human health and safety; protect water quality in the Edwards aquifer; share the impacts and hardship caused by drought; minimize economy disruption within the district so that employment and jobs are protected; and prevent Marcos Springs from going dry. Principles set forth were to: provide advance knowledge to the public of how water demands will be reduced during drought; provide for local manage-

ment and implementation of demand reduction measures; provide flexibility to change DMP as new information and alternative or supplemental water resources become available; control the rate of aquifer water levels by monitoring and reducing the volume of water pumped. The drought management plan provides objective numerical criteria for determining that drought conditions exist, how long they continue, and when a drought has ended. There are five stages of drought identified, each with associated trigger conditions and demand reduction goals. The next step for the EUWD is the adoption of these goals and objectives by users in the district. Plans must be submitted by August 1989. (See also W91-03032) (Lantz-PTT)
W91-03089

AQUIFER STORAGE RECOVERY: A NEW WATER SUPPLY ALTERNATIVE.
CH2M Hill, Inc., Gainesville, FL.
R. D. G. Pyne.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 12B-27--12B-31.

Descriptors: *Aquifer Storage Recovery, *Groundwater management, *Groundwater storage, *Water resources management, Alternative planning, Aquifers, Economic aspects, Florida, Groundwater budget, Groundwater quality, Groundwater resources, Saline water intrusion.

Aquifer Storage Recovery (ASR) is a relatively new concept to store potable water in a suitable aquifer during months when supply exceeds demand, and recovery from the same wells to meet peak seasonal, emergency or long-term demands. Eight ASR systems are operational in the US, with either development or testing underway at 14 additional sites in ten states. Florida has four operational ASR facilities and three more in testing or development. Typically all of the water restored is recovered and can be used without retreatment other than disinfection. By typically reducing the capital cost for water facilities expansion by at least 50%, ASR is increasingly being accepted by water utility managers as a desirable component of utility expansion plans. In some applications, an important advantage of ASR is the ability to improve system reliability in areas subject to emergency loss or contamination. In other areas, ASR can be used to prevent salt water intrusion, raise groundwater levels or control subsidence. By shifting the impact of surface water withdrawals from dry periods to wet periods, ASR is recognized as a positive and environmentally desirable water management tool; whether the period is seasonal or long-term. (See also W91-03032) (Author's abstract)
W91-03090

NATURAL RECHARGE OF BASEMENT AQUIFERS IN A SAHEL AND SUDAN CLIMATE: EXPERIMENTAL STUDY IN BURKINA FASO.
Bureau de Recherches Geologiques et Minieres, Orleans (France).
For primary bibliographic entry see Field 2F.
W91-03182

ARTIFICIAL RECHARGE OF GROUND WATER: STATE OF ART AND LIMITATIONS.
Central Ground Water Board, Ahmedabad (India).
P. N. Phadtare.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 299-314, 1 tab, 9 ref.

Descriptors: *Artificial recharge, *Developing countries, *Groundwater management, *Groundwater potential, *India, *Water resources development, *Water resources management, Drought, Economic aspects, Geologic control, Groundwater recharge, Management planning, Water quality, Water storage, Water supply development.

Artificial recharge is an important element in water resources management, by replenishing over-exploited aquifers, storing surplus surface water from wet seasons to dry seasons, improvement of water quality of groundwater or reclaimed wastewater, and to check ingress of saline water. Artificial recharge is carried out on a large scale only in a few countries around the world. In India very little has been done thus far in artificial recharge, but the scope for this technology is very large. Artificial recharge is achieved by three methods: spreading (highly permeable surface formations, shallow aquifers, source of water of inferior quality, deep aquifers with permeable or semi-permeable overburden, and source water of very good quality), induced recharge (aquifers with limited storage capacity), and injection (deep aquifers with impervious overburden, and source water of very good quality). A thorough and detailed knowledge of the geological, hydrological, and morphological features of the area are necessary for selecting sites for recharge structures. The cost of construction and cost of operation of the recharge structures, except in the case of injection wells in alluvial areas and tidal regulators, are reasonable in India compared to costs of such experiments in other countries. It has been found that rock formations with moderate permeabilities are most desirable for artificial recharge, which should be carried out only for augmenting domestic water supply as it is not economically viable for irrigation purposes. Drought relief work should be planned in advance and should include construction of new artificial recharge structures, renovation of old ones, and basinal development schemes. (See also W91-03178) (Fish-PTT)
W91-03196

SYSTEMS FOR ARTIFICIAL RECHARGE OF GROUND WATER.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
H. Bouwer.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 315-324, 2 fig, 8 ref.

Descriptors: *Artificial recharge, *Groundwater management, *Groundwater recharge, *Water resources development, *Water resources management, *Water supply development, Groundwater potential, Infiltration, Infiltration rate, Injection wells, Permeability, Recharge basins, Water quality, Water storage.

With artificial recharge of groundwater, surface water is infiltrated into the ground for storage in aquifers and eventual recovery from wells. Infiltration and flow to aquifers can be achieved with infiltration facilities on the surface. Such systems require permeable surface soils to obtain adequate infiltration rates, vadose zones without clay or other flow-restricting layers, and unconfined transmissive aquifers. Where these conditions do not exist, or where suitable land is too expensive, artificial recharge of groundwater can be achieved with wells. Recharge or injection wells are similar in construction to pumped wells. Infiltration facilities for groundwater recharge can be classified as in-channel (weirs, dams, levees) or off-channel (basins) systems. Because a number of factors govern the relation between water depth and infiltration rate, the water depth giving maximum infiltration rates must be evaluated by on-site experimentation. Since infiltration basins require permeable soils, identification of permeable soil profiles and site selection are extremely important. Aquifers should be sufficiently transmissive to keep groundwater mounds below the bottom of infiltration basins. Where hydraulic loading rates need to be maximized, infiltration systems should consist of a number of basins. The most important quality standard parameters of the water going into infiltration basins are the total dissolved solids and the sodium adsorption ratio, which control whether clay in the soil is flocculated (more permeable) or dispersed. There are hundreds of successful artificial groundwater recharge projects in the U.S. and in the rest of the world. (See also W91-03178) (Fish-PTT)
W91-03197

NNEPS (NATIONAL NETWORK FOR ENVIRONMENTAL POLICY STUDIES) FINAL REPORT: EPA (ENVIRONMENTAL PROTECTION AGENCY) REGION 1 WELLHEAD PROTECTION EFFORTS.
Yale Univ., New Haven, CT. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 5G.
W91-03227

APPROPRIATE METHODOLOGIES FOR DEVELOPMENT AND MANAGEMENT OF GROUNDWATER RESOURCES IN DEVELOPING COUNTRIES.
For primary bibliographic entry see Field 2F.
W91-03311

ROLE OF VERTICAL FLOW IN SEDIMENTARY AQUIFERS.
Birmingham Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-03315

ESTIMATING GEOHYDROLOGIC PARAMETERS FOR GROUNDWATER MANAGEMENT AND LAND SUBSIDENCE CONTROL IN KANTO PLAIN, JAPAN.
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 2F.
W91-03316

OPTIMAL PUMPING POLICY AND GROUNDWATER BALANCE FOR THE BLUE LAKE AQUIFER INVOLVING NON-LINEAR GROUNDWATER HYDRAULICS.
Indian Inst. of Tech., Bombay. Dept. of Civil Engineering.
A. K. Rastogi.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 545-568, 10 fig, 31 ref, append.

Descriptors: *Aquifers, *Blue Lake Aquifer, *California, *Drawdown, *Groundwater management, *Pumping, *Water resources development, Algorithms, Costs, Hydrologic budget, Mad River, Mathematical models, Optimization, Simulation, Water demand, Water yield.

Blue Lake Aquifer is an unconfined sloping aquifer in northern California overrun by the Mad River, which is regulated by Ruth Reservoir. High pumpage from the existing six wells of a few million gal/day (MGD) causes appreciable drawdown compared to the saturated thickness of the aquifer. Another set of 10 wells has been proposed for meeting an anticipated daily demand of 23 MGD. For this reason, reduction of the governing nonlinear groundwater flow equation into a linear equation was not considered appropriate. An existing explicit scheme was found most suitable for the solution of an inherently nonlinear equation. Many modifications to this existing algorithm were required before a groundwater balance was obtained for the Blue Lake Aquifer. The water management district wanted to minimize the pumping cost for lifting the proposed 23 MGD from 10 wells. This nonlinear optimization problem was solved using the most recent modified embedded approach incorporating the appropriate constraints based on the real system and on the optimization requirements. It was estimated that an annual savings of $20,000 was attainable by implementing the optimal pumping policy, which employed monthly planning periods, compared to a non-optimized policy (i.e., equal pumping of 2.3 MGD from each of 10 wells). (See also W91-03311) (Author's abstract)
W91-03317

NUMERICAL SIMULATION OF GROUNDWATER FLOW IN FUHRBERG FIELD, HANOVER.
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 2F.
W91-03320

COMPARATIVE MODEL STUDY FOR GROUNDWATER RESOURCES EVALUATION IN KELANTAN, MALAYSIA: PART 1. MODEL EVALUATION.
National Univ. of Malaysia, Bangi.
For primary bibliographic entry see Field 2F.
W91-03322

MODELLING THE EFFECTS OF PROPOSED PUMPING FROM THE TAMBRAPARNI RIVER BASIN, TAMILNADU, INDIA.
V.O.C. Coll., Tuticorin (India). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W91-03323

MANAGEMENT OF GROUND WATER RESOURCES IN COMPLEX AQUIFER SYSTEM OF RAJMAHAL TRAPS OF SAHEBGANJ DISTRICT, BIHAR.
S. H. A. Khan, and J. Raja.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 649-660, 1 tab, 4 ref, 2 map.

Descriptors: *Geohydrology, *Groundwater management, *Groundwater potential, *Groundwater resources, *India, *Water resources management, Arid lands, Basalts, Drought, Geologic fractures, Groundwater reservoirs, Groundwater storage, Gumani River, Rajmahal Traps.

The Sahebganj district of Bihar (India) is chronically drought prone, making the development of groundwater resources for assured and continuous water supply an important objective. A hydrogeological survey coupled with exploratory drilling in the Gumani River sub-basin of Sahebganj district revealed that a major part of the area is underlain by Rajmahal trap of upper Gondwana, having a huge thickness of basaltic flow. The Rajmahal traps comprise seven basaltic flows with white clay and chert separating intertrap beds. An attempt has been made to examine the groundwater possibilities in the typical trap country of Sahebganj district. It was shown that the basalts are productive when weathered or fractured. Fracture zones have been delineated both laterally and in depth. The existence of potential fracture zones at 30-35 m and 70-100 m has been established. In general, the Rajmahal traps show vertical to horizontal joints trending east-west and north-south. At places columnar joints also are well developed. These rocks are weathered with characteristic spheroidal exfoliation, which gives rise to large rounded boulders as the outcrop. Tensile fractures, which caused the development of secondary porosity in these otherwise impermeable rocks, provide suitable reservoirs for groundwater storage. The quantitative interpretation of aquifer parameters indicates the presence of a productive fractured zone. The estimated groundwater resource of the Sahebganj district is 241.95 million cubic meters (MCM). Since the net groundwater draft is only about 12.48, a remainder of 228.47 MCM is available for groundwater development. (See also W91-03311) (Rochester-PTT)
W91-03325

GONDWANA ARTESIAN BASIN IN WEST GODAVARI DISTRICT, ANDHRA PRADESH, INDIA.
For primary bibliographic entry see Field 2F.
W91-03327

GROUNDWATER DEVELOPMENT FOR DROUGHT RELIEF IN CHANDRAPUR DISTRICT, MAHARASHTRA.
Central Ground Water Board, Nagpur (India).
For primary bibliographic entry see Field 2F.
W91-03328

INDRAVATI-KOLAB BASINS OF KORAPUT AS POTENTIAL GROUND WATER RESERVOIRS OF THE PURANAS IN ORISSA.
National Environmental Engineering Research Inst., Nagpur (India).
For primary bibliographic entry see Field 2F.
W91-03330

GROUNDWATER MANAGEMENT PLANNING OF ALAPAKKAM AREA, TAMILNADU, INDIA.
Sri Venkateswara Univ., Tirupati (India).
M. Y. A. Baig, and A. Chandrasekhar Rao.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 685-688, 1 fig, 8 ref.

Descriptors: *Geohydrology, *Groundwater management, *India, *Safe yield, *Water resources development, *Water yield, Aquifers, Bay of Bengal, Coastal aquifers, Groundwater barriers, Kazmann method, Pumping, Saline water barriers, Saline water intrusion, South Arcot District, Specific yield, Water table rise, Well yield.

Groundwater conditions have been studied in extensively in part of the South Arcot district, along the coast of the Bay of Bengal, India. A groundwater reserve of about 55,960 ha m was determined for this area. Since the average thickness of the aquifer is 34 m, assuming an average value of specific yield of 0.15, the aquifer has 5100 mm in static storage versus an annual recharge of 269.6 mm. This static storage is about 4 yr total 4 yr total rainfall or 19 yr recharge. The Kazmann method was employed to determine safe yield; it is based on specific yield and the average rise in water table. The safe yield has been calculated as 1.52 cu m/sec, whereas the total withdrawal from the area is around 1.65 cu m/sec. This has resulted in an overdraft from the basin causing sea water intrusion in certain areas. Using the chloride-bicarbonate ratio to evaluate sea water intrusion, a steady increase in ratio from 0.5 to 2.9 over the period 1980-1986 was observed at one of the control wells about 8 km from the coast. At this rate, the entire belt is likely to be contaminated by sea water intrusion if the pumping pattern is not regulated. To control sea water intrusion, a subsurface physical barrier should be erected near the coast. A trench backfilled with compacted silty clay material might serve this purpose. (See also W91-03311) (Rochester-PTT)
W91-03331

GROUND WATER FLOW IN SOUTHERN PART OF KOSI ALLUVIAL FAN AND ITS EFFECT ON WATERLOGGING, WITH POSSIBLE REMEDIAL MEASURES, DISTRICT SAHARSA, BIHAR, INDIA.
Central Ground Water Board, Patna (India).
For primary bibliographic entry see Field 2F.
W91-03332

MEASURES TO OVERCOME THE SALINITY PROBLEMS OF THE COASTAL AREAS IN GUJURAT.
Gujarat Water Resources Dept., Gandhinagar (India).
J. F. Mistry.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 829-840, 2 fig, 2 ref, 2 append.

Descriptors: *Coastal areas, *Groundwater management, *Groundwater recharge, *India, *Saline water intrusion, Check dams, Dissolved solids, Geohydrology, Gujarat state, Gully plugs, Karst hydrology, Limestone, Pit recharge, Recharge wells, Tide gates, Water quality, Water table rise.

Misuse of land and groundwater in the vicinity of the coast in the Saurashtra region of Gujarat state (India) has created an ecological imbalance resulting in sea water intrusion. This has affected the quality of groundwater in about 120 villages. The most heavily affected region lies within a coastal strip of 160 km in length between Una and Madhavpur. About 12,562 wells are no longer usable in this area. The problem is exacerbated by the local geology, a highly cavernous and permeable limestone. Several steps have been taken to manage the problems in this area, including: establishment of committees to identify the problems and propose solutions; institution of salinity control measures (check dams, recharge tanks, recharge wells, and gully plugs); and monitoring of salinity advancement. Due to partial implementation of the mitigation scheme (138 check dams, 2 tidal regulators, 7 bandharas, 5 recharge tanks, 20 recharge wells, and 1516 nala plugs) as well as good rains in the 1988 monsoon, the recharge process in the Una-Madhavpur area has been reactivated. Post-monsoon monitoring of the water table and water quality indicates a rise in the water table and an improvement in water quality. Total dissolved solids of < 2000 ppm are found now in an area of approx 25,000 ha that had higher values prior to May 1988. (See also W91-03311) (Rochester-PTT)
W91-03345

SAFEGUARDS FOR GROUNDWATER POLLUTION IN INDIA.
Malvia Regional Engineering Coll., Jaipur (India).
For primary bibliographic entry see Field 5G.
W91-03346

UNDERGROUND STORAGE OF SURPLUS FLOOD WATERS IN GANGETIC PLAIN.
Tata Inst. of Fundamental Research, Bombay (India).
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 923-929, 5 fig.

Descriptors: *Artificial recharge, *Conjunctive use, *Floods, *Groundwater reservoirs, *Groundwater storage, *India, *Surface-groundwater relations, Drought, Ganges River, Groundwater level, Intermittent streams, Irrigation water, Monsoons, Seasonal distribution.

Generous rainfall during the months of July, August, and September causes floods in the Ganges River basin (India), followed by a shortage of water during dry months. The physiography and topography of the region provide a very limited scope for surface storage. There is some potential for storing surplus runoff in underground reservoirs for use during the dry period. A scheme has been devised in which existing natural reservoirs are emptied and then allowed to fill naturally without any extra engineering. The artificial part of the scheme consists of generating productive consumption by intensive irrigation, for the large quantity of water withdrawn. The emptied reservoir is expected to absorb part of the flood pulse as well. The most promising reservoirs appear to be the sandy aquifers connected with the beds of seasonal streams. Only one site (near Saharanpur) has been investigated so far. About 60 boreholes made to a depth of 50 m have encountered some clay lenses, which are not extensive. A drought in 1987 lowered the water table by 5-6 m in the project area, but floods during the 1988 monsoon restored the groundwater level. (See also W91-03311) (Rochester-PTT)
W91-03356

AUGMENTATION OF WATER RESOURCES IN CANAL COMMANDED AREA.
Roorkee Univ. (India). Water Resources Develop-

ment Training Center.
A. S. Chawla, and S. A. S. Ansari.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 931-943, 9 fig, 9 ref.

Descriptors: *Artificial recharge, *Canals, *Conjunctive use, *Groundwater management, *Hydraulic engineering, *Seepage, *Surface-groundwater relations, *Wells, Groundwater resources, Mathematical models, Optimization, Pumping, Storage coefficient, Well yield.

Optimizing the distance of augmentation wells from canals involves both factors of hydraulics and economics. Optimum distance of wells from a canal and the optimal spacing among wells were determined for the minimum unit cost of net pumped water. The effects of various aquifer and operational parameters were investigated. The average induced seepage from the canal due to pumping from a system of wells placed along the canal increases with decrease in the value of distance from the canal (a) and storage coefficient (S) and with increase in the continuous duration of pumping. The number and spacing of wells do not affect the induced seepage. The optimal distance of wells from the canal and spacing among the wells decrease with decrease in the values of S and increase in continuous pumping duration. The optimum distance of wells from the canal increases with decrease in S, increase in the value of the transmissibility and increase in duration of pumping. The value of the optimal distance from the canal increases with the increase in the value of the coefficient of transmissibility and the value of the optimal spacing between wells increases with the value of the annual pumping hours. However, value of the optimal distance from the canal is not affected by the change in the value of the annual pumping hours. The number of wells does not affect the optimal distance and spacing. Optimal spacing among wells is affected by the discharge of the wells. (See also W91-03311) (Rochester-PTT)
W91-03357

WATER CONSERVATION AND ARTIFICIAL RECHARGE TECHNIQUES IN HARD ROCK AREAS.
Central Ground Water Board, Bhopal (India).
S. Romani, and P. N. Sharma.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 959-968, 5 fig, 1 ref.

Descriptors: *Artificial recharge, *Geohydrology, *Groundwater recharge, *India, *Water conservation, Case studies, Drought, Reservoirs, Runoff, Surface-groundwater relations.

The Jhabua district in Madhya Pradesh (India) presents a situation where barren hard rocks with steep gradients are conducive to heavy runoff of surface water within a short period after rainfall. This drought-prone tribal district was studied and techniques were developed for water conservation and artificial recharge in the hard rock terrain of Jhabua district. Case histories are given here for sites representing lateral recharge (Sarangi), vertical recharge (Dhawarapara), and recharge by submergence (Jameri and Jawania). The technique of artificial recharge of groundwater by creating small surface reservoirs in favorable hydrogeological areas would help achieve optimal utilization of the water resources of the area. The role of hydrogeology in identifying the areas for water conservation and management is often neglected, leading to poor results. Selection and adoption of appropriate methods, as demonstrated in the four case histories, can bring about the best interaction between surface and groundwater in planning water conservation programs. (See also W91-03311) (Rochester-PTT)
W91-03359

POSSIBILITIES OF INDUCED RECHARGE AND DEVELOPMENT OF DEEPER AQUIFERS FOR AUGMENTING WATER SUPPLY TO AMBALA URBAN AREA, HARYANA STATE.
T. G. Firozuddin, G. Suryanarayana, D. S. S. Murthy, and K. V. J. R. Krupanidhi.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 979-988, 5 fig, 2 tab, 4 ref.

Descriptors: *Developing countries, *Groundwater management, *India, *Induced infiltration, *Water supply development, Ambala, Aquifers, Dangri River, Drawdown, Pumping, Urban areas, Well yield.

Concern is mounting regarding the problem of developing adequate water supplies in to the Ambala urban area because the locally available groundwater supplies via tubewells will not be able to meet growing demands. Studies were conducted to delineate the water table aquifer along the riverine tract of the Dangri River (India), the geometry and productivity of the aquifer, its capacity to hold the required amount of water, and possibilities for induced recharge. It is estimated that 2.66 million cubic meters (MCM) could be pumped out of the aquifer during the dry season. A tract along the Dangri River has an average saturated thickness of 14 m, and it is suggested that a well field could be constructed with an average discharge of 726 cu m/day for reach well. The well field should be laid parallel to the river on its western bank at a distance of 100 m from the river, keeping a spacing of 400 m between tubewells of 30 m depth. The corresponding drawdown in the center of the well field has been calculated as 7.77 m. About 10,800 cu m/day of groundwater could be withdrawn in summer to augment water supply in the Ambala urban area. With intensive development, water levels will go down, creating additional storage space for induced infiltration. The estimated induced recharge from the river to the aquifer is about 0.833 MCM during the monsoon season. The possibility also has been considered of developing 7.30 MCM of the deeper aquifers occurring below 150 m as an additional source of water supply. (See also W91-03311) (Rochester-PTT)
W91-03361

INDUCED RECHARGE BY PERCOLATION TANKS IN PARTS OF MAHARASHTRA.
Y. J. Pardhasaradhi.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 989-996, 3 fig, 2 tab, 2 ref.

Descriptors: *Artificial recharge, *Conjunctive use, *Groundwater recharge, *India, *Induced infiltration, *Pit recharge, Agricultural runoff, Aquifers, Developing countries, Evaporation, Maharashtra state, Monsoons, Seepage, Surface-groundwater relations, Watersheds.

Many percolation tanks have been constructed in Maharashtra state (India) by impounding minor water courses. The average catchment area is 3.5 sq km with an average gross storage of 200 thousand cubic meters (TCM). There are about 475 such tanks in the Sina and Man basins, where a representative study was made by selective monitoring of tank levels, contents, groundwater levels in wells, and evaporation rate. Evaporation on average accounts for 10.7% of total depletion of tank contents. An average percolation rate of 45 mm/day was estimated for the post-monsoon period. Some seepage may appear in water courses downstream. Those wells that are influenced by percolation show increased yield to 10-30% when water levels and the time factor are considered. The percolation observed generally was less during the monsoon period and immediately thereafter. This could be due to the saturated condition of the aquifers and the invisible subsurface inflow to the tank from the catchment. Clogging of the pores in the tank by silt and clay, as well as increased evaporation during the dry summer periods diminish the recharge from the percolation tanks from March onward. Selection of percolation tank sites above viable aquifers and regular removal of silt from the tank be before the onset of each monsoon should improve the performance of the percolation tank. Construction of a series of check dams across the stream course represent an alternative to percolation tanks. A drawback to percolation tanks is the temporary submergence of useful land while recharge is occurring. (See also W91-03311) (Rochester-PTT)
W91-03362

ARTIFICIAL GROUND WATER RECHARGE IN DROUGHT PRONE AREAS.
Central Ground Water Board, Hyderabad (India).
K. M. Subrahmanyam, and P. Prakasam.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 997-1004, 3 fig, 3 ref.

Descriptors: *Artificial recharge, *Drought, *Groundwater recharge, *India, *Induced infiltration, Agricultural runoff, Check dams, Groundwater storage, Percolation canals, Pit recharge, Surface-groundwater relations, Watersheds.

Artificial recharge of groundwater has assumed significance in drought-prone areas of Andhra Pradesh (India) during the last decade. Most of these drought-prone areas have limited surface water potential compelling heavy dependence on the groundwater resources to compelling heavy dependence on the groundwater resources to meet various requirements. These areas are mostly underlain by hard rocks, which form shallow aquifers of limited storage capacity. This geology, combined with erratic rainfall, make artificial groundwater recharge imperative in these areas. Construction of percolation tanks has occurred extensively at suitable locations. These tanks are economically viable and are of immense utility in augmenting groundwater resources. Public acceptance of percolation tanks is high, resulting in the demand that many existing minor irrigation tanks be converted to percolation tanks. A series of check dams is another way to substantially augment groundwater recharge while conserving soil and runoff in these watersheds. Recharge through percolation tanks and check dams has proven appropriate for local conditions. Percolation canals also have served well for aquifer recharge under certain conditions. (See also W91-03311) (Rochester-PTT)
W91-03363

HYDRAULIC FRACTURING TEST FOR GROUNDWATER SIMULATION IN A KARSTIC LIMESTONE AQUIFER, HATTINGEN/BADEN-WEURTTENBURG, WEST GERMANY.
Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
R. Jung, and S. Sankaran.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 1005-1015, 11 fig, 2 tab, 4 ref, 2 append.

Descriptors: *Germany, *Groundwater management, *Groundwater movement, *Hydraulic fracturing, *Karst hydrology, *Simulation, *Well development, *Well yield, Geologic fractures, Hydraulic machinery, Performance evaluation, Transmissivity.

In areas of low-permeability rocks, groundwater is transported mainly through bedding planes, natural joints, and fracture zones. Hydraulic fracturing employs high hydraulic pressure to the walls of

selected zones in a borehole until failure of the surrounding rock occurs. The aim is to increase well yield. Hydraulic fracturing tests were conducted at a depth of about 100 m in a borehole near Hattingen (Germany) in karstic limestone. The injection unit was a pump with a maximum pressure of 300 bars and a maximum flow rate of 400 L/min. Water level measurements made before and after the test showed that it was possible to connect a non-productive borehole in karstic limestone to water-carrying joints by inducing fractures hydraulically. The size of the fracture and the length of the intersection between the induced fracture and the natural joints could be increased after establishing the connection by injecting water with higher flow rates. The maximum pressure required to initiate fractures was 32 bars. A maximum width of 0.55 mm at fracture propagation was achieved with a flow rate of 6.64 L/min. The maximum transmissivity was achieved at 14.2 Darcy Meter. The exponential decay of fluid pressure after shut-in was analyzed to estimate the hydraulic parameters. The estimated residual transmissivity and fracture width were too low. This limited the specific yield to a value too low for large-scale groundwater supply. To achieve higher transmissivity and fracture width, acidifying the fracture or use of gels with or without propping materials are possible solutions. (See also W91-03311) (Author's abstract)
W91-03364

SIMULATION STUDY CONCERNING STIMULATION OF GROUNDWATER BORE WELLS BY HYDRAULIC FRACTURING.
National Geophysical Research Inst., Hyderabad (India).
T. N. Gowd, and M. Govardhan.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 1017-1024, 4 fig, 3 tab, 6 ref.

Descriptors: *Aquifers, *Groundwater management, *Hydraulic fracturing, *Model studies, *Simulation, *Well development, *Well yield, Frac fluids, Groundwater resources, Low-flow augmentation, Stimulation.

Vertical hydrofracture growth in the low-permeability aquifers (permeability 1, 25, 50, 75, or 100 md) was simulated using the Perkins-Kern-Carter two-dimensional hydrofrac model. The results indicate that the frac penetration of 60-100% of the drainage radius (about 235 ft) of groundwater borewells and a frac width of about 10 mm can be achieved by injecting a viscous frac fluid (viscosity = 50 CP) at a rate of 500 L/min for 40 min. Estimates of likely increases in well yield show an increase of 10-16 fold after stimulation. These results provide the theoretical basis for designing hydrofrac stimulation equipment and stimulation procedures. A hydrofrac pump with a discharge rate of 500 L/min at a pressure of 1500 psi should be employed for stimulating water wells by hydraulic fracturing. Gelled water with a viscosity of 50 CP should be used as a frac fluid to achieve desired frac length and frac width and to transport sand proppant into the fracture. Sand of 20-40 mesh size sand should be mixed with frac fluid in such a proportion that a 5-mm thick sand pack could be created in the fracture to achieve the desired relative conductivities. (See also W91-03311) (Rochester-PTT)
W91-03365

RIVER RECHARGE.
Caswell, Eichler and Hill, Inc., West Topsham, VT.
B. Caswell.
Water Well Journal WWJOA9, Vol. 44, No. 11, p 34-37, November 1990. 4 fig.

Descriptors: *Connecticut River, *Groundwater management, *Induced recharge, *Recharge, *Surface-groundwater relations, *Vermont, *Water resources development, *Wellhead protection, Aquifers, Federal jurisdiction, Glacial aquifers, Land use, State jurisdiction, Transmissivity, Water quality.

Important municipal groundwater supply issues today include delineation of Wellhead Protection Areas (WHPAs) and differentiation between 'true' groundwater and groundwater that is influenced by surface water. A Vermont community found itself facing these two issues when it decided to replace its existing municipal well. State regulations required that the community undertake a geohydrologic investigation of its aquifer as an integral part of the proposed new well construction. Delineation of a Wellhead Protection Area using test boring and test pumping information clearly showed that this groundwater source induces significant recharge from the nearby Connecticut River. Using the same information, the brook that is also adjacent to the well site was shown not to be an important source of induced recharge. This brook watershed was not recommended to be included within the Wellhead Protection Area. Because of the high transmissivity of this glacial stream aquifer and its close hydraulic coupling with the Connecticut River, the two zones of the Wellhead Protection Area are small, and thereby, require relatively little land purchase or land-use zoning by the community. Maintenance of good quality river water, however, should be addressed at state and federal levels of government. Even if the upstream Connecticut River basin is included in the Wellhead Protection Area, there is little that one town can do to control development of the large watershed and possible cumulative degradation of river water quality over time. Under current conditions, this riverside aquifer can provide a large volume of high quality groundwater. These conditions should be preserved. (Lantz-PTT)
W91-03390

POTENTIAL FOR AQUIFER COMPACTION, LAND SUBSIDENCE, AND EARTH FISSURES IN AVRA VALLEY, PIMA AND PINAL COUNTIES, ARIZONA.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-03670

GROUND WATER RECHARGE: DEMONSTRATION PROGRAM AND POLICY ISSUES.
Bureau of Reclamation, Denver, CO.
For primary bibliographic entry see Field 6B.
W91-03718

BIRTH OF A MEGAPROJECT: POLITICAL ECONOMY OF FLOOD CONTROL IN BANGLADESH.
Massachusetts Univ., Amherst. Dept. of Economics.
J. K. Boyce.
Environmental Management EMNGDC, Vol. 14, No. 4, p 419-428, 1990. 2 fig, 43 ref.

Descriptors: *Bangladesh, *Economic aspects, *Flood control, *Political aspects, *Project planning, Decision making, Evaluation, Flooding, Long-term planning, Public participation, Water management.

A major flood control initiative has been launched in Bangladesh under the coordination of The World Bank. The Bank's five year action plan is intended to initiate a long-term investment program, the specifics of which remain to be determined. Long-term proposals under consideration include the construction of massive embankments along the rivers of the Bangladesh delta. The wisdom of such a structural solution to Bangladesh's problems can be questioned on economic, environmental and technical grounds. So far, the supposed beneficiaries of flood control in Bangladesh--the country's poor majority--have been virtually excluded from the decision making process. The World Bank concedes that past embankment projects have been undermined by deliberate cutting of embankments by disgruntled farmers and fishermen, and hence calls for 'closer involvement of the beneficiaries' and 'more cooperation among farmers.' It provides no inkling, however, of how these are to be achieved in a context of military-based rule and a highly inequitable land ownership pattern. In the future, officials of the international agencies and the Bangladesh government will further consider how to treat the 'wounds of nature' in the delta, erecting a long-term strategy upon the foundation of the current five-year plan. (Lantz-PTT)
W91-03873

TATIARA PROCLAIMED REGION, SOUTH-EASTERN SOUTH AUSTRALIA: HYDROGEOLOGICAL INVESTIGATIONS AND GROUNDWATER MANAGEMENT.
South Australian Dept. of Mines and Energy, Adelaide.
F. Stadter, and A. J. Love.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 253-259, 1990. 7 fig, 1 tab, 8 ref.

Descriptors: *Australia, *Groundwater budget, *Groundwater management, *Groundwater mining, *Groundwater recharge, *Water resources management, Geohydrology, Groundwater irrigation, Groundwater quality, Hydrologic budget, Irrigation water, Leaching, Saline groundwater, Salts, Unconfined aquifers.

In 1984 a significant area of the upper southeast of South Australia was proclaimed under the South Australia Water Resources Act, to manage groundwater withdrawals in the region. Following the proclamation of the Tatiara region, geohydrological investigations were undertaken to assess the groundwater availability of the region; groundwater supplies are obtained from an extensive unconfined aquifer. Geohydrological conditions vary significantly throughout the region, with changes in aquifer lithology, depth of water table and groundwater quality. Preliminary groundwater assessments indicate that groundwater use for irrigation purposes in some areas was close to or possibly exceeded acceptable levels of groundwater extraction. Monitoring of groundwater quality has shown increased groundwater salinity in a number of observation wells, particularly in the western part of the region. These increases are mainly due to the localized leaching of salts left in the soil profile following irrigation. An assessment of groundwater resources was made by determining the water balance of several areas within the region, total groundwater availability being the sum of the recharge to the aquifer and the lateral groundwater inflow. In order to maintain the maximum possible groundwater throughflow in these areas, groundwater use should not exceed localized recharge. (Author's abstract)
W91-03899

EVALUATION OF AQUIFER BEHAVIOR AND CHARACTERISTICS IN THE SINGRAULI COALFIELD, CENTRAL INDIA.
Indian School of Mines, Dhanbad. Dept. of Applied Geology.
For primary bibliographic entry see Field 2F.
W91-03914

4C. Effects On Water Of Man's Non-Water Activities

EVALUATION OF FARMING SYSTEMS.
Agricultural Research Service, Lincoln, NE.
J. S. Schepers.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 23-24.

Descriptors: *Agriculture, *Environmental impact, *Farm management, *Nonpoint pollution sources, *Water pollution control, Biological studies, Chemical interactions, Cultivated lands, Cultural control, Economic aspects, Multiobjective planning, Physical control, Research priorities.

Evaluation of farming systems for their impact on the environment goes well beyond the simple consideration of soil erosion and nutrient transport. When developing an evaluation scheme it is meaningful to start by considering generalized concepts and progressing to the level of specificity necessary to address the concern, rather than take existing data and be limited to hit and miss evaluations. As the evaluation becomes more detailed, it usually becomes necessary to involve an increasing number of disciplines. It is rare that scientists ever have the desired level of technical information considered necessary to fully evaluate farming systems. It should be recognized that isolation of factors contributing to a concern or problem usually involves a complex aggregation of biological, chemical, and physical processes. Therefore an integrated and multidisciplinary approach is highly desirable when evaluating farming systems. Types of data needed to evaluate cropping systems are quite diverse, but the environmental considerations must ultimately address the feasibility of modified cultural practices and the economic viability of farming practices. To be successful, evaluation requires time and appropriate funding to assemble a well-trained group of scientists to research farming systems. These research activities should be conducted concurrently with development of decision aids to facilitate technology transfer. (See also W91-02985) (Fish-PTT)
W91-02990

REGIONAL WATER MANAGEMENT AGENCY INVOLVEMENT IN LOCAL GOVERNMENT COMPREHENSIVE PLANNING.
Southwest Florida Water Management District, Brooksville.
For primary bibliographic entry see Field 6A.
W91-03036

ESTABLISHING VARIABLE WIDTH BUFFER ZONES BASED UPON SITE CHARACTERISTICS AND DEVELOPMENT TYPE.
Dames and Moore, Tallahassee, FL.
For primary bibliographic entry see Field 4D.
W91-03049

ANALYSIS OF WETLAND LOSS IN LAKE GEORGE BASIN USING HISTORICAL AERIAL PHOTOGRAPHY.
State Univ. of New York Coll. at Plattsburgh. Center for Earth and Environmental Science.
For primary bibliographic entry see Field 2H.
W91-03051

MODELING THE HYDROLOGIC IMPACTS OF PHOSPHATE MINING AND RECLAMATION IN CENTRAL FLORIDA.
Bromwell and Carrier, Inc., Lakeland, FL.
R. M. Powers, P. R. Davis, and M. Ross.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 13A-23--13A-33, 1 tab, 8 ref.

Descriptors: *Environmental effects, *Mine wastes, *Model studies, *Phosphates, *Regulations, Computer models, Florida, Geographic information systems, Groundwater quality, Permits, Research priorities, Water resources management.

In May of 1988, the Florida Institute of Phosphate Research (FIPR) funded a four year research project to develop a computer model that would accurately predict the hydrologic impacts of phosphate mining on surface and groundwater systems. The research project is directed by a Hydrology Advisory Committee, with the goal of developing a user friendly, interactive hydrologic model that will serve as the standard for evaluating future hydrologic permitting activities between the phosphate mining industry and local and state regulatory agencies. The core of the model will be a highly analytical geographic information system (GIS). Selection of the appropriate GIS is critical to the success of the hydrologic modeling project, as it will function as a central database and data exchange medium for the surface and groundwater models. The interactive GIS/hydrologic model will utilize the EPA's Hydrology Simulation Program-Fortran (HSPF) surface water model and the MacDonald-Harbaugh groundwater model (MODFLOW) as the basis for hydrologic analysis. The model will be calibrated, completed, and available for distribution to the user community in May, 1991. (See also W91-03032) (Lantz-PTT)
W91-03082

FISHERY FUNCTIONS AND VALUES OF FORESTED RIPARIAN WETLANDS.
Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures.
For primary bibliographic entry see Field 2H.
W91-03084

DESERT ENCROACHMENT IN EGYPT'S NILE VALLEY.
Minya Univ. (Egypt). Soil Science Dept.
For primary bibliographic entry see Field 2G.
W91-03120

CONSEQUENCES OF HEAVY MECHANIZATION AND NEW ROTATION ON RUNOFF AND ON LOESSIAL DEGRADATION IN NORTHERN FRANCE.
Office de la Recherche Scientifique et Technique Outre-Mer, Paris (France).
E. J. Roose, and F. X. Masson.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 24-33, 1 fig, 2 tab, 22 ref.

Descriptors: *Agricultural practices, *France, *Loess, *Runoff, *Soil erosion, *Tillage, Agriculture, Organic matter, Regional studies, Soil degradation, Val de Canche.

Erosion problems have increased substantially over the last 10 yr in northern France, prompting farmers to ask for assistance. The effect of mechanization on soil degradation is a widespread problem. It was investigated in the Val de Canche area of France, using three levels of analysis: area administration level, farmer and plot level, and at the regional geographic level using scientific techniques. As problems and solutions seemed clearer, field tests were made with volunteer farmers to evaluate the influence of intermediate crops on soil cover in winter and the effect of excessive tilling on germination and cereal production. Simulated rainfall tests and soil erodibility measurements also were made as part of this program. Investigations made with area administration and local farmers showed that erosion occurred mainly in the zone of loessial plateaus. However, erosion intensity varied with the type of cultivation. Organic matter content was lowest and soils were the most degraded where mechanized cultivation had occurred for the longest period of time, as in the regions of Artois and Cambraisis. The old system of cultivation mixed animal raising with crop raising; the modern approach is to use heavy equipment to plant and harvest various commercial crops. Tests showed that runoff began later and remained lower in places where the old cropping system was in use. A second test showed that the more the topsoil was pulverized by successive vibro-driven and rapid passes of various types of harrows, the higher was runoff and the less likely were cereal seeds to germinate (asphyxia) and push through the sealing crust. (See also W91-03117) (Rochester-PTT)
W91-03121

EFFECTS OF GRAZING AND TRAMPLING ON SOIL DETERIORATION AROUND RECENTLY DRILLED WATER HOLES IN THE SAHELIAN ZONE.
Office de la Recherche Scientifique et Technique Outre-Mer, Abidjan (Ivory Coast).
C. Valentin.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 51-65, 10 fig, 2 tab, 26 ref.

Descriptors: *Livestock, *Sahel, *Senegal, *Soil erosion, *Water holes, Arid lands, Ferlo Region, Grazing, Soil compaction, Soil physical properties, Wells.

As recently as 30 yr ago, a large region in northern Senegal was known as the 'Ferlo Desert' and this area was used by nomadic livestock raisers. Herdsman left the area when ponds dried up, so they were gone 9 months in each year. Since the 1950s, when numerous deep wells were drilled, seasonal migrations declined substantially and year-round stock raising became the rule. A cooperative study was conducted recently focusing on the changes that have occurred; major findings relevant to grazing and trampling around waterholes that degrades soils, namely sealing, soil compaction, and wind and water erosion, are presented. Three representative drilled waterholes were selected for the study, two in sandy areas and one on the cuirassed Ferlo. Heavy trampling and intense grazing around waterholes cause land degradation in the Sahel belt. However, the magnitude of the deterioration depends on the ecological surroundings. On the sandy Ferlo, plant degeneration is not always induced by animal husbandry. Regeneration can occur surprisingly rapidly, provided rainfall returns to normal. In these sand regions, land damage occurs mainly in the form of wind erosion. In contrast, any change that disturbs the frail balance in the cuirassed Ferlo (e.g., drought, enhancement of pastoral practices) leads to the much more extensive destruction associated with accelerated water erosion. Some processes, such as soil crusting, result much more from a combination of natural factors than from any impact of animal husbandry, which is often incorrectly blamed. Some practices, such as limited nomadism during the rainy season, represent a spontaneous answer to the problem of overgrazing around wells. (See also W91-03117) (Rochester-PTT)
W91-03122

EFFECTS OF VARIOUS VEGETATION LAYERS IN AN ACACIA AURICULIFORMIS FOREST PLANTATION ON SURFACE EROSION IN JAVA, INDONESIA.
Agricultural Univ., Wageningen (Netherlands). Dept. of Forest Management.
For primary bibliographic entry see Field 2J.
W91-03124

SOIL EROSION STUDIES IN THE NORTHERN MOUNTAIN RANGE, TRINIDAD, UNDER DIFFERENT CROP AND SOIL MANAGEMENT.
University of the West Indies, St. Augustine (Trinidad and Tobago). Faculty of Agriculture.
F. A. Gumbs, J. I. Lindsay, M. Nasir, and A. Mohammed.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 90-98, 1 fig, 6 tab, 14 ref.

Descriptors: *Slope protection, *Soil conservation, *Soil erosion, *Soil management, *Trinidad, *Vegetation effects, Corn, Cowpea, Farming, Flooding, Nitrogen losses, Runoff, Tillage.

Steep slopes (> 40%) dominate Trinidad's northern mountain range. Farmers practice shifting cultivation. They clean-fell and burn the vegetation before planting at the start of the wet season. Uncontrolled and malicious fires contribute to the exposure of bare soil, accelerated erosion, and a rapid increase in the incidence and severity of flooding. Runoff, soil losses, inorganic N losses in runoff and eroded sediments, and crop yields were studied on experimental plots on Maracas soils (Orthoxic Tropudult (Ultisol) of the isohyperthermic clayey oxidic family). Plots were laid down on slopes of three mean values (11, 22, and 52%). Corn (Zea mays) or cowpea (Vigna unguiculata) were planted, with bare soil and tilled and untilled plots. There was significantly more runoff and inorganic N loss in runoff from bare plots than from cropped plots. The higher concentration of inorganic N in runoff water from bare plots also contributed to the higher N losses per hectare. Runoff did not increase significantly with increased slope from 11 to 22% or from 22 to 52%, but tillage on the 22% slope significantly decreased runoff from the bare soil. Total inorganic N losses in runoff during the rainy season were low (max 6.8 kg/ha on 52% slope). Soil losses from bare,

uncropped plots increased significantly with increased slope from 11 to 22% and 22 to 52%. Tillage on the 22% slope significantly increased soil loss. There was no significant effect of slope or of tillage on maize and cowpea yields on the 22% slope. This was expected because there was no significant difference in soil loss or N loss. The greater runoff and soil loss from bare soil than from cropped soils demonstrates the need to keep soil covered with vegetation. Clean cultivation of maize and cowpea, even on 52% slopes, was enough to reduce soil loss to tolerable levels under the rainfall conditions of 1977. (See also W91-03117) (Rochester-PTT)
W91-03125

QUANTIFYING EROSION-CAUSING PARAMETERS IN A NEW ZEALAND WATERSHED.
South Canterbury Catchment Board and Regional Water Board, Limaru, New Zealand.
For primary bibliographic entry see Field 2J.
W91-03126

CROP YIELD REDUCTION DUE TO REDUCED PLANT AVAILABLE WATER CAUSED BY WATER EROSION.
Technische Univ., Munich (Germany, F.R.). Lehrstuhl fuer Bodenkunde.
H. H. Becher, U. Schwertmann, and H. Sturmer.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 365-373, 1 fig, 1 tab, 16 ref.

Descriptors: *Agricultural watersheds, *Available water, *Crop yield, *Soil erosion, *Soil-water-plant relationships, Contour cropping, Corn, Germany, Loess, Slope effects.

In southern Bavaria (Germany), corn (Zea mays) production has increased from 0 in 1950 to about 30% of the cultivated acreage in 1980. This has led to increased soil erosion because crop canopy cover is sparse in the spring. Water erosion of the loess layer exposes sandy Tertiary sediments on the steeper parts of slopes, leading to considerable reductions in crop yields. An attempt was made to quantify these yield decreases by studying six farmer-operated hill slopes cropped with corn for silage in the years 1978, 1979, and 1980. On each of the slopes, yields of gravelly plots always were much lower than on loessial plots, by 20 to 40% in 1978 and 1979 and by as much as 50% in 1980, the year with normal rainfall (414 mm). Plants were taller on loessial plots in all three years. Ear numbers were somewhat less on gravelly plots and ear weights were substantially less 1.13 kg/sq m versus 1.97 kg/sq m. To reduce soil loss in this area, contour cropping, less corn in the rotation, and planting winter barley in strips 8-10 m apart on the contour simultaneously with corn are recommended. (See also W91-03117) (Rochester-PTT)
W91-03144

SIMPLIFIED SEDIMENT YIELD MODEL FOR SMALL AREA DISTURBANCES ON SURFACE-MINED LANDS.
Simons, Li and Associates, Inc., Fort Collins, CO.
G. K. Cotton, and R. M. Li.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 585-597, 6 fig, 2 tab, 12 ref. Office of Surface Mining Contract J5110061.

Descriptors: *Erosion control, *Hydrologic models, *Model studies, *Sediment control, *Sediment yield, *Soil erosion, *Strip mines, Calculators, Mine runoff, Performance evaluation, SIMSED model, Sediment discharge.

A physical model is more useful than a statistical model for describing the behavior of sediment-control structures than models based on broad regression analysis. Physical models however, are complex and usually require access to a computer. SIMSED is a physically-based model that can be solved with a hand-held calculator. It can be applied over a wide range of soils, covers, and treatment conditions. The mathematical bases for SIMSED are equations for sediment and water continuity, uniform overland flow, and sediment detachment and transport capacity. Four groups of measures and structures are used commonly to control sediment yield from a catchment: (1) surface protection measures, such as mulches, vegetation, and mats; (2) mechanical treatment, such as ripping, pitting, and land surface manipulation; (3) diversion structures, such as terraces; and (4) detention structures. These measure or structures control one or more physical characteristics of the catchment and, therefore, affect sediment detachment or transport capacity. For example, surface protection measures provide ground cover, which absorbs raindrop impact and reduces raindrop-induced soil detachment. These measures increase initial abstraction capacity and infiltration rate of the soil. They also increase overland flow roughness, thereby reducing the level of sediment transport capacity of the overland flow. With information on the amount of ground cover provided by a surface protection measure, the SIMSED procedure can be executed. An eight-step procedure is used to determine the total sediment yield from a small area. Use of SIMSED allows a realistic comparison of sediment control structures. Mechanical treatment increases initial abstraction volume, infiltration, and roughness, but it does not control raindrop detachment. Diversion structures reduce slope length and, therefore, the overland flow discharge, but they do not modify the initial abstraction volume, infiltration, or raindrop detachment. Detention structures provide a location for sediment deposition. The effective design of these structures depends on the particle size and other characteristics of sediment and upon the quantity of sediment reaching the detention area. (See also W91-03117) (Rochester-PTT)
W91-03166

OVERCOMING MYTHS ABOUT SOIL AND WATER IMPACTS OF TROPICAL FOREST LAND USES.
East-West Center, Honolulu, HI.
L. S. Hamilton.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 680-690, 34 ref.

Descriptors: *Deforestation, *Developing countries, *Forest hydrology, *Policy making, *Tropical regions, Afforestation, Climates, Myths, Reforestation, Soil conservation.

In many developing countries forest land use policies are predicated the forest's assumed effects on certain watershed hydrologic characteristics and soil erosion control and sediment reduction benefits. In some cases there is a scientific basis for these assumptions, but others are based on folklore, myth, or misinterpretation of research. Some policies are discussed that have been advocated based on supposedly sound soil or water conservation rationales, but which in fact have little, or even countervailing, scientific support. The issues considered are: cutting reduces rainfall; cutting reduces water supplies; cutting causes floods; shifting agriculture causes erosion and reservoir sedimentation; grassland is better than forests; and reforestation or afforestation is a panacea for water problems. There are many sound reasons for forest conservation and reforestation in the tropical developing countries. Foresters should not condone the use of unsupportable or questionable hydrologic and erosional relationships in this important policy area. (See also W91-03117) (Rochester-PTT)
W91-03173

SECONDARY ECONOMIC IMPACT OF ACID DEPOSITION CONTROL LEGISLATION IN SIX COAL PRODUCING STATES.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5G.
W91-03220

IMPACT: AN EXPERT SYSTEM FOR ENVIRONMENTAL IMPACT ASSESSMENT.
Westinghouse Savannah River Co., Aiken,SC.
For primary bibliographic entry see Field 6G.
W91-03240

REGIONAL ASPECTS OF WETLANDS RESTORATION AND ENHANCEMENT IN THE URBAN WATERFRONT ENVIRONMENT.
Rosenstiel School of Marine and Atmospheric Science, Miami, FL.
J. R. Clark.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 497-515, 9 fig, 1 tab, 24 ref.

Descriptors: *Ecosystems, *Urban watersheds, *Water resources management, *Wetland restoration, *Wetlands, Aquatic productivity, Governmental interrelations, Management planning, Regional planning, Water resources development.

In urban settings, wetland resources are typically degraded and often seriously dysfunctional. Loss of wetland function in this manner reduces the productivity of the larger aquatic ecosystems of which the wetlands are a component. Therefore, in urban settings a high priority must be given to restoration and enhancement of aquatic ecosystems and to their component wetlands. Success in system-wide restoration requires formulation of a regional strategy with goals, objectives, methodologies, and predesignated restoration sites. Such strategies must be locally generated and cannot be substituted by existing one-agency programs. All levels of government and private interests must be involved. Moreover, the existing system of site-by-site permit review must be altered to ensure that permit decisions are oriented toward the regional restoration strategy. It is particularly important to recognize that the developers' resources will be the main source of restoration project funds through voluntary or mitigative restoration and enhancement. Therefore, mitigation has to be given a role at the beginning of the review process and not held until the end as a 'last resort.' (See also W91-03244) (Author's abstract)
W91-03268

WETLAND AND WATERBODY RESTORATION AND CREATION ASSOCIATED WITH MINING.
Pennsylvania State Univ., University Park. Forest Resources Lab.
R. P. Brooks.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 529-548, 3 fig, 93 ref.

Descriptors: *Artificial wetlands, *Management planning, *Mining engineering, *Strip mine lakes, *Water resources management, *Wetland restoration, *Wetlands, Environmental engineering, Habitat restoration, Hydrological regime, Literature review, Water resources development.

Published and unpublished reports are reviewed and the strategies and techniques used to facilitate the establishment of wetlands and waterbodies during mine reclamation are summarized. Although the emphasis is on coal, phosphate, and sand and gravel operations, the methods are relevant to other types of mining and mitigation activities. The following key points should receive attention during planning and mitigation processes: (1) development of site-specific objectives that are related to regional wetland trends; (2) integration of wetland mitigation plans with mining operations and reclamation at the beginning of any project; (3) wetland designs that mimic natural systems and provide flexibility for unforeseen events; (4) ensurance that basin morphometry and control of the hydrologic regime are properly addressed before considering other aspects of a project; and (5) identification of mandatory monitoring as a known cost. Well-designed studies that use comparative approaches (e.g., pre-mining versus post-mining, natural versus restored systems) are needed to increase the database on wetland restoration technology. Meanwhile, regional success criteria for different classes of wetlands need to be developed by consensus agreement among professionals. The rationale for a particular mitigation strategy must have a sound, scientific basis if the needs of mining industries are to be balanced against the necessity of wetland operation. (See also W91-03244) (Author's abstract)

W91-03270

SIMULATION OF REGIONAL HYDRODYNAMICS IN THE NEYVELI AQUIFER.
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 2F.
W91-03321

DROUGHTS AS MEANS OF DELINEATION OF AREAS PRONE TO SEA WATER INTRUSION.
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 2F.
W91-03336

GROUNDWATER QUALITY MONITORING: STATISTICAL MODELING.
Kakatiya Inst. of Tech. and Science, Warangal (India).
K. S. V. Basivi Reddy, and M. Pandu Ranga Rao.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 755-759.

Descriptors: *Groundwater quality, *India, *Model studies, *Monitoring, *Water quality, Bicarbonates, Calcium, Chlorides, Dissolved solids, Magnesium, Mathematical models, Potassium, Prediction, Salinity, Sodium, Statistics, Wells.

Water quality obtained from the Warangal (India) urban area was subjected to multiple regression analysis. Fifty-eight wells were monitored for five seasons and each sample was analyzed for 13 parameters. The results of the analysis were used to suggest models for predicting water quality. Overall, it appears that sodium, either independently or in association with potassium, magnesium, calcium, and bicarbonates, determines the total dissolved solids (TDS). Chlorides, either independently or in association with bicarbonates and magnesium, appears to be important contributors to TDS. Using predictive models developed from the regression analysis, the behavior of an indicator of water quality, such as specific conductivity could be predicted as a way of indicating TDS. A single simple test is sufficient for predicting water quality in this area. (See also W91-03311) (Rochester-PTT)
W91-03338

LANDSLIDES IN THE UPPER JORDAN GORGE.
Haifa Univ. (Israel). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W91-03433

SALT MARSH MITIGATION: AN EXAMPLE OF THE PROCESS OF BALANCING MOSQUITO CONTROL, NATURAL RESOURCE, AND DEVELOPMENT INTERESTS.
Indian River Mosquito Control District, Vero Beach, FL.
For primary bibliographic entry see Field 6G.
W91-03441

LAND-USE CHANGES: EFFECT ON WATER QUALITY IN THE PINE CREEK WATERSHED.
Lapeer County Drain Commission, MI.
D. E. Birkle.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 227-234, 1 fig, 3 tab, 5 ref.

Descriptors: *Great Lakes, *Land use, *Nonpoint pollution sources, *Water pollution sources, *Water quality management, *Water resources management, *Watershed management, Agricultural runoff, Clean Water Act, Drainage water, Farm wastes, Water quality.

The Pine Creek (Michigan) watershed has 11,542 acres which were used predominantly as farmland until 1965. In 1964, 61 parcels of land were 80 acres or larger and only 43 parcels were 20 acres or smaller. Today only 23 parcels of land remain which are 80 acres or larger. A study under the 208 Program of the Clean Water Act indicated that Pine Creek could be a significant source of nonpoint pollution due to tight soils and high artificial drainage characteristics. Since that time major reconstruction has occurred on 7.1 miles of watercourse and Interstate 69 has transected the watershed. Soil erosion and sedimentation control devices were included. The overall impact of these projects does not seem to have affected the water quality at the point of discharge or in upper portions of the watershed. (See also W91-03672) (Author's abstract)
W91-03697

EFFECTS OF CO 2-INDUCED CLIMATIC CHANGES ON SNOWPACK AND STREAMFLOW.
Agricultural Research Service, Boise, ID. Northwest Watershed Research Center.
K. R. Cooley.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 5, p 511-522, October 1990. 5 fig, 3 tab, 26 ref.

Descriptors: *Climatic changes, *Environmental effects, *Global warming, *Hydrologic models, *Montana, *Precipitation, *Rainfall-runoff relationships, *Snowpack, *Streamflow, Carbon dioxide, Climatology, Mathematical models, Snowmelt, Streamflow forecasting.

Atmospheric concentrations of carbon dioxide (CO2) may double during the next century, causing changes in the Earth's climate. Warming of up to 4 degrees, slight cooling, and 10% changes in precipitation have been projected. The effects of climatic change on streamflow from a snowmelt-dominated basin in southwestern Montana, were investigated. The National Weather Service River Forecast System model was first calibrated using data for the 1973-1984 period. Daily temperature and precipitation values were then changed, and the model run again to assess the effects on snowpack and streamflow of some possible climatic changes. Changing the air temperature by only 2-4 degrees may have a significant impact on the accumulation and melt of a snowpack depending on the original temperature regime of the site. For example, if the normal temperature range is near the threshold temperature that delineates rain from snow, a small change in temperature could change the snowpack considerably. Changes in streamflow are somewhat less than changes in snowpack since some of the snow that is changed to rain upon warming still finds its way to the stream. Results indicate that streamflow may vary by from -22 to +45% depending on the combination of climatic changes imposed. (Hoskin-PTT)
W91-03842

BIODIVERSITY LOSS IN THE TEMPERATE ZONE: DECLINE OF THE NATIVE FISH FAUNA OF CALIFORNIA.
California Univ., Davis. Dept. of Wildlife and Fisheries Biology.
For primary bibliographic entry see Field 6G.
W91-03870

PREDICTION, VALIDATION, MONITORING, AND MITIGATION OF ANTHROPOGENIC EFFECTS UPON NATURAL SYSTEMS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 5C.
W91-03871

INTEGRATING FORAGE, WILDLIFE, WATER, AND FISH PROJECTIONS WITH TIMBER PROJECTIONS AT THE REGIONAL LEVEL: A CASE STUDY IN SOUTHERN UNITED STATES.
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
L. A. Joyce, C. H. Flather, P. A. Flebbe, T. W. Hoekstra, and S. J. Ursic.
Environmental Management EMNGDC, Vol. 14, No. 4, p 489-500, 1990. 2 fig, 3 tab, 49 ref.

Descriptors: *Case studies, *Ecological effects, *Fish populations, *Forestry, *Land use, *Resource management, *Water resources, *Wildlife, Forecasting, Model studies, Public policy.

The impact of timber management and land use change on forage production, turkey and deer abundance, red cockaded woodpecker colonies, water yield and trout abundance was projected as part of a policy study focusing on the southern United States. The multi-resource modeling framework used in this study linked extant timber management and land area policy models with newly developed models for forage, wildlife fish and water. Resource production was integrated through a commonly defined land base that could be geographically partitioned according to individual resource needs. The most basic recommendations for the future are: (1) to make all resource areas equally important in the specification of information for an accurate description of the environmental system under study; and (2) to deal with feedback concepts. The current multiple resource framework only addresses the impacts of land use and timber management on other resources. Modifications of the growth and yield functions based on changes in other resource production levels would initiate an evolution toward an interactive analysis and improve the capability to represent the complexity of multiple resource systems. A related recommendation involves expansion of economic factors affecting land management activities to include the economics of managing forage, water, trout, or wildlife. The economic value of these resources affects the transition of land to other uses and how timber is managed. Currently, the value of these other resources is not considered when analyzing how private landowners allocate their land resources to various uses and intensities of timber management. (Lantz-PTT)
W91-03877

QUANTIFICATION OF HYDROCHLORIC ACID AND PARTICULATE DEPOSITION RESULTING FROM SPACE SHUTTLE LAUNCHES AT JOHN F. KENNEDY SPACE CENTER, FLORIDA, USA.
Bionetics Corp., Cocoa Beach, FL.
For primary bibliographic entry see Field 5B.
W91-03878

EFFECT OF LAND CLEARANCE IN THE MALLEE REGION ON RIVER MURRAY SALINITY AND LAND SALINISATION.
South Australian Dept. of Mines and Energy, Adelaide.
S. R. Barnett.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 205-208, 1990. 8 fig, 2 tab, 7 ref.

Descriptors: *Australia, *Groundwater budget, *Groundwater recharge, *Land clearing, *Land use, *Murray-Darling River Basin, *River basin development, *Saline groundwater, Computer models, Environmental effects, Geohydrology, Groundwater level, Revegetation, Saline water intrusion.

Widespread clearing of native vegetation has dramatically increased recharge in the Mallee region of the River Murray basin in South Australia by up to two orders of magnitude. The resultant rising water tables have caused land salinization problems in low-lying areas and, in the long-term, will increase saline groundwater inflows to the River Murray with a consequent rise in river salinity. Computer modeling suggests that, 50 years after the water table begins responding to the increase in recharge, an increase of 70 electrical conductivity units in river salinity will occur at the town of Morgan, in the northwest sector. Broadscale revegetation in strategic areas adjacent to the river will reduce saline groundwater inflows, and the eco-

nomic and social aspects of this measure should be investigated. (Author's abstract)
W91-03894

IS BROADSCALE REVEGETATION ECONOMIC AND PRACTICAL AS A GROUNDWATER AND SALINITY MANAGEMENT TOOL IN THE MURRAY-DARLING BASIN.
La Trobe Univ., Bundoora (Australia). School of Agriculture.
R.G. Dumsday, R. Pegler, and D. A. Oram.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 209-218, 1990. 69 ref, 2 append.

Descriptors: *Australia, *Forest management, *Land use, *Resource management, *Revegetation, *Saline groundwater, *Saline soils, *Surface-groundwater relations, Economic feasibility, Farming, Forestry, Geohydrology, Groundwater recharge, Murray-Darling River Basin, River basins, Saline water intrusion, Vegetation effects, Water quality.

In the Murray-Darling Basin of South Australia, land degradation has caused an estimated loss of $214.6 million/year. Clearing and the replacement of deep-rooted native vegetation by shallow-rooted annuals have been identified as major causes of increased groundwater recharge and land and water degradation. Improved vegetation management and revegetation of degraded lands will lead to significant improvement in surface water quality. Recharge strategies include reforestation and agroforestry, agronomic and engineering strategies. Current arrangements for marketing commercial timber, setting prices, and levying taxes discourage private tree plantings, as do a lack of labor and management skills, the relative profitability of alternatives, and availability of capital. Though there are apparent benefits from forestry-based activities, which simultaneously control groundwater levels and dryland salinity, farmers need incentives to move to forestry-based systems. Most research predicts a net social gain from reduction in salinity problems, but the importance of water yield has been neglected. Model specification is important to the selection of appropriate land use. Broadscale revegetation using tree-based systems is not economic or practical as a groundwater and salinity management tool, but should be evaluated in terms of local conditions. In addition, vegetation management should be more widely interpreted to include all vegetation which may be used to control groundwater and salinity. (Author's abstract)
W91-03895

4D. Watershed Protection

ESTABLISHING VARIABLE WIDTH BUFFER ZONES BASED UPON SITE CHARACTERISTICS AND DEVELOPMENT TYPE.
Dames and Moore, Tallahassee, FL.
R. R. Potts, and J. L. Bai.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 6A-3--6A-14, 8 fig, 2 tab, 5 ref.

Descriptors: *Buffer zones, *Environmental protection, *Florida, *Land use, *Water management, *Water resources management, Model studies, Runoff, Site selection, Suwannee River, Urbanization, Vegetation.

A technique for establishing variable width buffer zones for land development along the Suwannee River in Florida is described. A minimum buffer zone width of 75 feet was established by the Suwannee River Water Management District, a regional regulatory agency. The amount of additional buffer zone width required at any location along the river was established by use of a model using SCS runoff curve numbers, which account for soil type, natural vegetation, development type, and area of proposed impervious surface. The model generates a series of curves which can be used to easily determine the minimum buffer zone width required for any type of development and site characteristics found along the river. For a given set of pre-existing site conditions the buffer zone width is dictated by the development type. Data for three locations along the Suwannee River are presented as examples. The technique can be easily adapted to other water bodies with a minimum of effort and shows potential as a valuable tool for water resources planning and management. (Author's abstract)
W91-03049

SOIL EROSION AND CONSERVATION.
For primary bibliographic entry see Field 2J.
W91-03117

SOIL CONSERVATION IN INDIA.
Central Soil and Water Conservation Research and Training Inst., Dehra Dun (India).
V. V. Dhruva Narayana, and G. Sastry.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 3-9, 5 tab, 16 ref.

Descriptors: *Agricultural practices, *Erosion control, *India, *Soil conservation, *Soil erosion, *Soil stabilization, Ditches, Doon Valley, Gully erosion, Landslides, Monsoons, Research, Terraces.

In India, about 175 million of the nation's 328 million ha of land are degraded by soil erosion. According to recent estimates, nearly 6,000 million tons of soil are displaced and transported annually; most is lost to the sea. The Central and Soil and Water Conservation Research and Training Institute and its Research Centers have developed various conservation practices, which are described here. Contour terraces and graded terraces are important soil and water conservation measures in areas with up to 600 mm of annual precipitation and high infiltration and permeability rates. As an alternative to contour and graded terraces, conservation ditching was tried in the deep black soils of peninsular India. This practice employs trapezoidal ditches laid out on the contour at the same vertical interval as the contour or graded terraces. Graded trenches or diversions on arable land with 10-16% slopes also reduce runoff and soil losses. Experiments in the Doon Valley showed that about 16% of monsoon rainfall can be harvested from agricultural watersheds treated with drainage-type terraces. Trees have been shown to be beneficial in protecting non-arable land by intercepting rainfall and reducing the energy of raindrops striking the soil surface, thus reducing soil detachment. Special soil erosion problems include ravines (severe gully erosion), which affects an estimated 4 million ha of land, and landslides, which account for an estimated annual loss of 350 million rupees. Measures have been developed for stabilizing gullies and for minimizing the economic damage caused by landslides. (See also W91-03117) (Rochester-PTT)
W91-03118

SOIL AND WATER CONSERVATION PROBLEMS IN THE CENTRAL PLAINS OF VENEZUELA.
Universidad Central de Venezuela, Maracay. Facultad de Agronoma.
I. Pla, A. Florentino, and D. Lobo.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 66-78, 4 fig, 1 tab, 16 ref.

Descriptors: *Crop yield, *Mulches, *Soil conservation, *Venezuela, *Water conservation, Corn, Runoff, Soil moisture deficiency, Soil water, Sorghum.

In the northern Central Plains of Venezuela, rainfed crop production, mainly sorghum and recently corn, has developed during the last 15 yr. The actual cropped area is around 100,000 ha. An attempt was made to measure and distinguish, under natural field conditions, the influence of soil and water conservation on rainfed crop production in a representative soil of the northern Central Plains of Venezuela. Data for three consecutive years (1979-1981), which had different amounts and distribution of rainfall, were related to permanent experimental plots planted to sorghum. From the first harvest, the highest yields were in all cases obtained in treatment A (100% of soil surface covered by asphalt mulch), whereas the lowest yields were obtained with treatment B (bare soil). The treatment with 50% cover of asphalt mulch (A-B) produced a much lower yield than treatment A, but larger than B, especially in the relatively dry 1980 season. Runoff and soil losses were not appreciable in treatment A during the growing seasons of 1979 and 1980. The relatively large soil losses in treatment B in 1979 did not appear to be the primary cause of the observed reduced yield compared with treatment A. Soil moisture deficit, which existed for only a few days in 1979, but occurred during the critical periods for soil water stress (floral initiation, anthesis, and grain filling), appeared to have been long enough to explain most of the yield reduction. Similarly, in 1980, the soil moisture deficit was least in treatment A, greatest in treatment B, and intermediate in treatment A-B. This factor seemed to explain the differences in grain year in 1980. This study demonstrated that soil moisture regime affects yield significantly in these soils and that water conservation measures can have a beneficial effect on yield. (See also W91-03117) (Rochester-PTT)
W91-03123

EFFECTS OF VARIOUS VEGETATION LAYERS IN AN ACACIA AURICULIFORMIS FOREST PLANTATION ON SURFACE EROSION IN JAVA, INDONESIA.
Agricultural Univ., Wageningen (Netherlands). Dept. of Forest Management.
For primary bibliographic entry see Field 2J.
W91-03124

SOIL EROSION STUDIES IN THE NORTHERN MOUNTAIN RANGE, TRINIDAD, UNDER DIFFERENT CROP AND SOIL MANAGEMENT.
University of the West Indies, St. Augustine (Trinidad and Tobago). Faculty of Agriculture.
For primary bibliographic entry see Field 4C.
W91-03125

MODEL FOR QUANTIFYING INCENTIVE PAYMENTS FOR SOIL CONSERVATION IN CROPPING REGIONS SUBJECT TO WATER EROSION.
La Trobe Univ., Bundoora (Australia). School of Agriculture.
R. G. Dumsday, and W. D. Seitz.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 296-306, 2 fig, 4 tab, 10 ref.

Descriptors: *Contracts, *Payment, *Public policy, *Soil conservation, *Soil erosion, Administration, Computer models, Economic aspects, Erosion control, Illinois.

About 50% of the soil conservation practices supported by the United States federal government from 1975 through 1978 were on land that already met 'tolerable' standards of soil conservation. This fact has led to calls for better targeting of funds, accompanied in many cases by mandatory controls over land use and management practices. An attempt was made to develop 'conservation achievement contracts' between governments and landowners. Under these contracts, landowners agree to adopt farming systems that meet the goals of soil and water conservation agencies acting on behalf of society in return for financial compensation, if necessary. The contracts run for 5-10 yr, subject to renegotiation clauses. To quantify the payments to be made under a conservation achievement contract program, a deterministic computer model (SOILEC) was employed; it encompassed the on-site physical and financial consequences of soil erosion. Data from 16 soil types in Illinois were used to test the model and the procedures for establishing conservation achievement contracts. For all locations but one, the marginal costs of erosion reduction increase sharply as soil loss decreases. The one exception is an extreme case in a physical sense, incurring heavy soil losses under all by the most stringent loss minimizing approach

with a net annual revenue of only $42.84 per hectare. The structure and operation of SOILEC should allow the adoption of a system of individual conservation achievement contracts between farmers and governments to achieve social goal of soil and water conservation programs. However, the costs of administering such a scheme have yet to be estimated. (See also W91-03117) (Rochester-PTT)
W91-03140

SOIL AND WATER CONSERVATION IN SEMIARID REGIONS.
Agricultural Research Service, Akron, CO. Central Great Plains Research Station.
B. A. Stewart, P. W. Unger, and O. R. Jones.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 328-337, 4 fig, 13 ref.

Descriptors: *Great Plains, *Semiarid lands, *Soil conservation, *Tillage, *Water conservation, Agricultural runoff, Conservation tillage, Crop yield, Furrow dams, Herbicides, Irrigation, Seasonal distribution, Soil water, Texas, Water use efficiency.

Annual precipitation in semiarid regions of the United States averages 250 to 500 mm. Precipitation in any given year may vary from 200% above to 50% below these average amounts. The most successful way to control erosion in semiarid regions is to develop better water management strategies. Emerging technologies permit more effective water use, reduced erosion, and increased crop yield. Examples cited here are mainly from the southern Great Plains of the United States, but the concepts apply to many areas of the world where similar conditions exist. Technologies that have increased the efficient use of limited water resources include: (1) management of crop residues as a mulch to increase soil water storage; (2) use of furrow dams to prevent stormwater runoff; and (3) conjunctive use of limited irrigation with inherently unpredictable rainfall. Conservation tillage is not widely used in the Great Plains, accounting for only 7% of the cropland. Studies conducted in Texas have demonstrated that use of stubble mulch tillage resulted in less wind erosion, higher soil water content, and greater wheat yields than with conventional tillage. Use of herbicides to replace tillage affords both erosion protection and better water management, along with producing better yields that compensate for the cost of the herbicides. Furrow dams were first used in the Great Plains in the 1930s. Conservation of runoff with furrow dams can result in large yield increases (for example, 1,660 and 1,210 kg/ha in 1980 and 1981, respectively, in one test at Etter, Texas. The limited irrigation-dryland (LID) concept is designed to allow more land to be irrigated in years of above-average rainfall. Also, furrow irrigation is used without causing runoff from the field and to prevent runoff of in-season rainfall. Research results to date show that in most years the fields managed under the LID system can successfully retain and use all seasonal rainfall and limited amounts of irrigation water without releasing runoff. In the long run this could result in substantial improvement in water-use efficiency. (See also W91-03117) (Rochester-PTT)
W91-03141

IMPROVED RAINFED FARMING FOR SEMI-ARID TROPICS: IMPLICATIONS FOR SOIL AND WATER CONSERVATION.
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India). Farming Systems Research Program.
P. Pathak, S. M. Miranda, and S. A. El-Swaify.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 338-354, 7 fig, 9 tab, 6 ref.

Descriptors: *India, *Semiarid lands, *Soil conservation, *Tropical regions, *Water conservation, Agricultural watersheds, Alfisols, Dry farming, Economic aspects, Farm equipment, Infiltration, Institutions, Monsoons, Vertisols.

Alfisols and Vertisols are major soil orders found in the semiarid tropics. The International Crops Research Institute for the Semi Arid Tropics (ICRISAT), in Hyderabad, India, has studied a wide range of soil and water conservation and cropping management systems in small, natural watersheds on Vertisols and Alfisols in an area with mean annual rainfall of about 760 mm. Determinations were made of runoff, soil erosion, crop production, rainfall use efficiency, labor use efficiency, and profitability in operational-scale research using both improved and traditional animal-drawn implements. Although Alfisols and Vertisols of the semiarid tropics often occur in close association, there management requirements and hydrologic characteristics are very different. On Vertisols the broadbed and furrow systems effectively controlled soil and water loss while the reverse was true with Alfisols. On Alfisols the raised land configurations (narrow ridge, wavy type bed, and others) that expose the lower soil layer (relatively less pervious) resulted in higher runoff and soil loss compared with the flat, on-grade system. On Vertisols most of the raised land configurations provide well-structured and drained media and are quite stable. Water intake capacity of Vertisols early in the monsoon season is high due to deep cracks and high depression-storage capacity. Micro-cracks have a significant effect on reducing runoff. In contrast, Alfisols have an initially high infiltration rate but are subject to surface sealing early in the rainy season caused by raindrop impact and fine-particle translocations on bare soil. Thus, early cover is more important on Alfisols than Vertisols. Vertisols have a problem of surface drainage. (See also W91-03117) (Rochester-PTT)
W91-03142

CONTROLLING EROSION AND SEDIMENT LOSS ON FURROW-IRRIGATED LAND.
Agricultural Research Service, Kimberly, ID. Snake River Conservation Research Center.
D. L. Carter.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 355-364, 5 fig, 3 tab, 8 ref.

Descriptors: *Agricultural practices, *Agricultural runoff, *Erosion control, *Furrow irrigation, *Soil erosion, Cost analysis, Minibasins, Mulching, Runoff control systems, Sediment basins, Sediment discharge, Vegetation effects, Vegetative filters.

During the past 5 yr, considerable research has been directed toward evaluating present practices for reducing erosion and sediment loss on furrow-irrigated land. Currently emphasis is being placed on reducing erosion and sediment loss on individual fields. The erosion control and sediment removal efficiency of five practices (sediment basins, minibasins, vegetative filters, straw in furrows, and buried-pipe runoff control systems) were examined and the advantages and disadvantages of each approach were considered. The buried-pipe runoff control system is the most cost-effective practice evaluated to date. It is the preferred practice in most instances, particularly where convex ends are present. Vegetative filters and minibasins are useful control practices, but both require more intensive management than the buried-pipe runoff control system. The two practices are considerably less costly, however, and thus should be considered as short-term controls. Placing straw in furrows on critical slope areas can be a useful control practice. Sediment basins always will have a place in sediment removal schemes on furrow-irrigated silt-loam soils. They are costly to clean, but their use greatly reduces sediment loss into rivers and streams. Furthermore, when other practices fail, sediment basins are a good back-up control. Applying the practices available to a basin will decrease sediment loss by about 80%. (See also W91-03117) (Rochester-PTT)
W91-03143

EROSION CONTROL IN URBAN RIVER VALLEYS: TORONTO, ONTARIO.
Surrey District, Vancouver (British Columbia).
A. S. Stratton.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 393-398.

Descriptors: *Erosion control, *Management planning, *Ontario, *Urban hydrology, *Urban watersheds, Economic aspects, Government finance, Policy making, Sedimentation, Urbanization.

Rapid urbanization of the Toronto metropolitan area has led to a proportionate increase in erosion problems in Toronto's urban river valleys. The effects of this valley erosion have produced several areas of concern, including danger to dwellings, loss of private property adjacent to valleys, loss of 'active and passive' parklands and associated structures, degradation of ravines and loss of valuable urban space, loss of fertile soil and mature vegetation, and sedimentation. The resulting sedimentation has contributed to reduced capacity of channels, sewers, flood control reservoirs, and other impoundments. It has interfered with navigable waterways and the Toronto harbor, and has affected water quality and fish habitat. Several specific causes of sedimentation and erosion have been identified, including inadequate construction setbacks, fill problems, stormwater management, destruction of vegetation, and inadequate planning and design of structures. The Metropolitan Toronto and Region Conservation Authority devised a management plan that includes a protective component and a preventive component, each with several specific steps for action. To make sure the program is effective, the following are recommended: (1) action must be taken early to be effective; (2) appropriate funding is imperative to correct existing problems, which will increase at a greater rate as the urban population expands; (3) all levels of government must adopt consistent policies, legislation, and bylaws to prevent or control future problems; (4) adequate administration of regulations and bylaws must be ensured; and (5) the public should be made aware of the valley system and the proper use of its invaluable resources. (See also W91-03117) (Rochester-PTT)
W91-03147

QUANTIFICATION OF EROSION CONTROL BY VEGETATION ON PROBLEM SOILS.
Corps of Engineers, Vicksburg, MS.
C. R. Lee, and J. G. Skogerboe.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 437-444, 6 fig, 4 tab, 4 ref.

Descriptors: *Construction sites, *Erosion control, *Rainfall simulators, *Vegetation effects, *Vegetation establishment, Acidic soils, Correlation analysis, Fertilizers, Grasses, Hydrogen ion concentration, Performance evaluation, Soil erosion, Soil water.

Most methods for long-term erosion control on construction sites emphasize establishment of vegetation as soon as possible after construction. However, some soils, such as acid pyritic materials, are difficult to vegetate. Laboratory and field experiments were conducted to quantify the erosion control afforded by vegetation using a rainfall simulator developed at the Waterways Experiment Station. In the laboratory, storm events were simulated on a vegetated soil bed lysimeter to evaluate the influence of plant cover, slope, and soil moisture on surface water quality. The simulator was then taken to the field, where similar storm events were simulated and runoff water quality was measured to verify laboratory results. The simulator is a rotating disk type with two nozzles, each capable of spraying 130 L/min. A slitted disk rotates under each nozzle at 200 rpm, creating a maximum rainfall intensity of 7.4 cm/hr over a 5.57 sq m area. The field plots (15 x 15 m) were established near Corinth, Mississippi, to demonstrated the effectiveness of current techniques for revegetating acid pyritic soil (pH 2.9 initially). Amendments of lime, lime + phosphate, lime + manure, and lime + phosphate + manure were used with weeping lovegrass, bahiagrass, or sericea lespedeza. Raising the soil pH to 5.5 with amendments resulted in good growth of all species. Manure enhanced growth, but manured plots contained large amounts of weeds. A good correlation was demonstrated in the laboratory between increased biomass over the range 0 to > 3000 kg/ha and decreased suspended solids load. A similar rela-

tionship was observed in the field. The good correlation between laboratory and field results means that laboratory procedures can determine the minimum biomass cover required for effective erosion control at a project site and the effectiveness of various plant species can be compared. (See also W91-03117) (Rochester-PTT)
W91-03152

PERCENT CROWN COVER RELATED TO WATER AND SOIL LOSSES IN MOUNTAINOUS FOREST IN THAILAND.
Kasetsart Univ., Bangkok (Thailand). Faculty of Forestry.
For primary bibliographic entry see Field 2J.
W91-03154

IMPACT OF CHECK DAMS ON STEEP MOUNTAIN CHANNELS IN NORTHEASTERN TAIWAN.
Taiwan Forestry Research Inst., Taipei.
C.-M. Liu.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 540-548, 5 fig, 4 tab, 16 ref.

Descriptors: *Channel erosion, *Check dams, *Dam effects, *Erosion control, *Mountain streams, *Sediment control, *Storm runoff, *Taiwan, Channel scour, Channel storage, Sediment discharge, Sediment yield, Slope effects, Typhoons.

Two-thirds of Taiwan is steep mountains. Three or four times each year, Pacific typhoons drench Taiwan with torrential storms. Check dams have been the most common structures for upstream sediment control. Detailed observations were conducted, beginning in 1979, to determine the changes in channel cross-section, channel gradient, and bed-load size composition after check-dam construction and to evaluate the effectiveness of check dams. A detailed survey was performed of the original profiles in streams of three watersheds and bedload particle size composition was analyzed to help understand the influence of check dams on channels. Periodically, selected channel cross-sections downstream from dam sites were surveyed. Accumulated sediment and its depositional pattern behind the check dams were obtained from periodic surveys upstream from dam sites. In the upper reaches of the dam sites, deposited material caused aggradation of the channel, reduced local stream gradient, increased channel width, and changed sediment size distribution. In the lower reaches, channel scouring was accelerated. Sediment yield rates decreased until a dam filled, but downstream scour tended to offset the benefits of storage of deposits. Check dams also might have fostered unforeseen adjustment downstream, possibly destabilizing streambanks and bridge foundations. Check dams can be a stabilizing or destabilizing agent. In recent years, dam construction in upstream channels has become a common tool of sediment control in this area. Results suggest that this tool requires reevaluation. The sediment control effort might benefit from improved understanding of characteristics of stream channels in which mass erosion is the dominant factor of sediment production. (See also W91-03117) (Rochester-PTT)
W91-03161

GULLY SIDEWALL DEVELOPMENT IN NEW SOUTH WALES, AUSTRALIA.
Macquarie Univ., North Ryde (Australia). School of Earth Sciences.
For primary bibliographic entry see Field 2J.
W91-03165

SIMPLIFIED SEDIMENT YIELD MODEL FOR SMALL AREA DISTURBANCES ON SURFACE-MINED LANDS.
Simons, Li and Associates, Inc., Fort Collins, CO.
For primary bibliographic entry see Field 4C.
W91-03166

CROP RESIDUE MULCH FOR CONSERVING SOIL IN UPLANDS OF INDONESIA.
Center for Soils Research, Bogor (Indonesia).
Suwardjo, and S. Abujamin.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 607-614, 3 fig, 4 tab, 9 ref.

Descriptors: *Agricultural runoff, *Erosion control, *Indonesia, *Mulching, *Soil conservation, *Tillage, Beans, Cassava, Corn, Fertility, Organic matter, Peanuts, Rice, Soil physical properties.

Land degradation in Indonesia is a serious problem in upland agriculture. In Java, were the supply of new land is very limited, farmers commonly plant steep slopes with annual food crops. Soil productivity decreases rapidly, because most farmers do not use soil conservation practices. Experiments were conducted to determine the effects of residue mulch on erosion, organic matter content, soil physical conditions, and soil productivity. Investigations were carried out at five locations: Citayam (Haplorthox soils), Lampung (Tropudult soils), Putat (Tropudalf soils), Citaman (Tropudalfs), and Punung (Tropudalfs). Bare, mulched, and unmulched plots (22 x 3 m and 22 x 2 m) were studied. The mulch was crop residue, which, except for the first planting, was applied at a rate of about 8-12 t/ha each year. Minimal tillage was used on the mulched plots; unmulched plots were plowed at planting times. Annual food crops, such as upland rice, maize, peanut, cassava, and beans were planted in a rotation system. Mulch and minimum tillage reduced erosion and runoff and improved physical characteristics of the Haplorthoxes and Tropudult soils. The mulch reduced kinetic energy of rainfall and flow rate of runoff. It also helped increase aggregate percentage and crust formation and improve the stability index. The percentages of aeration pores were 18-20 on mulched plots, whereas the soil on unmulched plots was slightly compacted and had aeration percentages of less than 12. The residue encourages biological activity and therefore promotes better soil structure. Organic matter content of the mulched plots was stable, whereas that of the unmulched plots declined. Mulch can reduce maximum soil temperatures by 6-12 C at 5 cm soil depth and 4-6 C at 10 cm soil depth. The present experiments showed that land degradation in uplands of Indonesia is caused mainly by soil erosion and loss of soil organic matter. Crop residue mulch applied at a rate of about 10 t/ha/yr reduced soil loss on slopes up to 15%. The mulch also helped maintain organic matter content, improve soil physical properties, and maintain soil productivity. (See also W91-03117) (Rochester-PTT)
W91-03167

SOIL CONSERVATION AND LAND DEVELOPMENT IN NORTHERN THAILAND.
New South Wales Dept. of Agriculture, Deniliquin (Australia).
D. Marston, C. Anecksamphant, and R. Chirasathaworn.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 634-643, 6 fig, 1 tab, 10 ref.

Descriptors: *Developing countries, *Erosion control, *International agreements, *Soil conservation, *Thailand, Bank erosion, Mulching, Performance evaluation, Silting, Swiddening, Tillage.

The Thai-Australia World Bank Land Development (TAWLD) Project is concerned with the large-scale conversion of uplands in northern Thailand from shifting cultivation to permanent, annual rainfed cropping and some associated woodlot. In the development phase, heavy earthmoving equipment is used to clear the vegetation, which consists mainly of secondary undergrowth. For this project and the Thai-Australia Land Development (TALD) Project, soil conservation measures have been earthwork structures, which have not always provided good control of soil erosion. Current research is aimed at developing appropriate crop management practices for farmers to use in conjunction with earthworks where necessary. The project sites are in the nine provinces of northern Thailand. Three types of soil conservation structures are used in current TAWLD Project areas: graded contour banks (terraces), level (absorption) banks, and gully control structures (check dams). Although research on the effectiveness of these and other techniques is not sufficient for definite conclusions, some useful information has emerged. For example, it has been demonstrated that substantial erosion control benefits can be obtained from stubble mulching and no-tillage compared with conventional clean cultivation. Modified broadbed-and-furrow systems, in contrast, did not show any substantial benefits. Excessive interbank erosion, channel siltation, and bank failures are continual problems in many years because of land clearing methods, lack of farmer education in the use of conservation management practices, and administrative constraints that prevent the use of appropriate soil conservation measures on steeper slopes above or within project areas. The traditional farming practice of swiddening evolved to allow for periodic build-up of nutrients, organic matter, and soil structure. Annual cropping systems must consider these aspects through appropriate crop management. (See also W91-03117) (Rochester-PTT)
W91-03169

CROP GEOMETRY: A NONMONETARY INPUT FOR REDUCING EROSION IN CORN ON FOUR PERCENT SLOPE.
Central Soil and Water Conservation Research and Training Inst., Dehra Dun (India).
S. P. Bhardwaj, M. L. Khybri, S. Ram, and S. N. Prasad.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 644-648, 3 fig, 1 tab, 5 ref.

Descriptors: *Agricultural watersheds, *Corn, *Erosion control, *India, *Plant spacing, Crop geometry, Crop yield, Doon Valley, Planting management, Slope effects, Storm runoff, Vegetation effects.

In northern India's Doon Valley and the adjoining hilly region of Outer Himalaya, corn is an important crop and erosion is a serious problem. The rainy season brings heavy downpours and the sloping, silty soils are highly erodible. A study was conducted to determine how increasing the distance between rows and decreasing the distance between plants would affect erosion and runoff. Plant population was kept constant. Eight runoff plots of 100 x 20 m were each equipped with a stage-level recorder, H flume, and Coshocton silt sampler for measurement of runoff and soil loss. Four sets of plantings were used: 45 x 40 cm, 60 x 30 cm, 75 x 24 cm, and 90 x 20 cm (between x within rows, respectively). Corn was rain fed and fertilized. Treatment plots with the widest interrow spacing (90 cm) and closest intrarow spacing (20 cm) had the lowest average annual runoff and soil loss in each of the three years of the study. Grain yield differences among the four treatments did not appear significant. Wider row spacing may permit easier and faster sowing and cultural operations and may increase the potential for intercropping. (See also W91-03117) (Rochester-PTT)
W91-03170

CONSERVATION TILLAGE: AN IMPORTANT, ADAPTABLE TOOL FOR SOIL AND WATER CONSERVATION.
Soil Conservation Service, Washington, DC.
G. M. Darby.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 649-653, 1 tab, 17 ref.

Descriptors: *Agricultural practices, *Agricultural runoff, *Conservation tillage, *Erosion control, *Mulches, Herbicides, Rill erosion, Sheet erosion, Tillage, Wind erosion.

Conservation tillage is a system of tillage that leaves protective amounts of crop residue on the soil surface during periods when growing crops do not provide cover and when erosive rains, runoff, snowmelt, or winds normally occur. The major types of conservation tillage systems are no-till, strip tillage, or till-planting, stubble mulching, and chemical fallow or ecofallow. No-till involves

planting with a special planter equipped with residue-cutting coulters. Normally, no other soil disturbance occurs. Weeds are controlled with herbicides instead of tillage. In strip tillage, till-planters sweep some residue aside and prepare narrow seedbed strips, sometimes on raised ridges of soil, free of crop residue. No more than one-third of the surface is disturbed. This system leaves more bare soil than no-till, but prevents excessive erosion when farming operations are on the contour. Stubble mulch tillage is a system that uses chisel and sweep-type implements for seedbed preparation and weed control. Protective amounts of crop residue are left on the surface. Weeds are controlled solely through tillage. Chemical and ecofallow is a system of fallow that relies on herbicides rather than on tillage. It is used in subhumid and semiarid zones. Conservation tillage is an effective way of controlling wind erosion and reducing rill and interrill erosion. On some land, this agronomic practice alone will control soil erosion. Farmers and researchers are developing conservation tillage technologies that can be used on different soils and in different climates. For example, strip tillage in Indiana may be suitable for fine-textured, poorly drained soils if residue-free strips on low ridges are used. The ridges aid drainage and the warming and drying of the soil in spring. (See also W91-03117) (Rochester-PTT)
W91-03171

PROGRAM APPROACH TO SOIL CONSERVATION.
Victoria Soil Conservation Authority, Kew (Australia).
D. N. Cahill.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 674-679, 1 tab.

Descriptors: *Developing countries, *Erosion control, *India, *Policy making, *Soil conservation, *Watershed management, Management planning, National soil conservation policy, Public policy, Social aspects, Soil conservation programs.

A national soil conservation policy, to be effective, must be based on a perspective of a nation's problems. Three essential ingredients of soil conservation are finance, technology, and a strategy of approach. In developing countries, soil conservation needs often are widespread and thus demand a nationwide solution. This means that projects that work successfully for a limited area may not be valid because resources do not exist to expand them country-wide. By long association, watershed management has become indistinguishable from its common means of implementation, the watershed management project. While the soundness of the watershed concept cannot be questioned, the project approach exacts certain penalties, including: projects are slow on a catchment-by-catchment basis; projects are expensive; projects present a complex extension message when the need is for extension recipes; and projects discriminate against the more marginal elements of the economy. The simple answer to these problems is for the recipient of aid to define what he wants. He needs a policy framework against which to view proposed investments in their true, national perspective. There are two ways to establish this framework: (1) intuitively, which often produces inadequate results, and (2) by analysis of the facts of the situation to establish a logical basis for action programs. Such an exercise was conducted for India. The analysis indicates the need for a program of vegetation measures of low per-hectare cost carried out over a broad area, with companion projects for reducing social constraints. The current approach, in contrast, consists almost exclusively of projects that are characterized by an intensive and wide range of works carried out in limited areas in a limited time at a high per-hectare cost with no provision for social back-up. National soil conservation policy must be based on perspective and a recognition of scale. The project approach, by focusing on a limited area, diverts attention from the broad, national view. The program approach, based on an analysis of the overall situation, ensures a perspective of the whole system. (See also W91-03117) (Rochester-PTT)
W91-03172

RESEARCH STRATEGY FOR ASSESSING THE EFFECT OF EROSION ON FUTURE SOIL PRODUCTIVITY IN THE UNITED STATES.
Agricultural Research Service, Tucson, AZ. Southwest Watershed Research Center.
K. G. Renard, and R. F. Follett.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 691-702, 15 ref.

Descriptors: *Public policy, *Research priorities, *Soil and Water Resources Conservation A, *Soil conservation, *Soil erosion, Erosion-Productivity Impact Calculator M, Management planning, Model studies, Performance evaluation, Tillage.

The 1977 Soil and Water Resources Conservation Act (commonly known as RCA) directs the Secretary of Agriculture to make periodic appraisals of soil, water, and related resources and their conservation on agricultural lands, and to make informed, long-range policy decisions regarding the use and protection of these resources. A linear programming model has been instituted for determining the best national management policies. However, several additional areas of research need exist, including: erosion-productivity research, soil erosion-soil productivity modeling, erosion/productivity experimentation, studies of water and wind erosion mechanics, and research on conservation tillage (in the areas of regional or local autonomy, a unifying concept to guide tillage research, and a multidisciplinary research approach). The research needed to quantify soil erosion-soil productivity relationships has been formulated to provide a national perspective for the problem. Some facets of the new research already are under way; others are being planned or require availability of new resources. The EPIC (Erosion-Productivity Impact Calculator) model, which is in its final phase of testing, will permit significant improvement in projections for the 1985 RCA report over those in the 1980 report. (See also W91-03117) (Rochester-PTT)
W91-03174

SOIL EROSION AND ITS CONTROL IN DEVELOPING COUNTRIES.
Food and Agriculture Organization of the United Nations, Rome (Italy).
F. W. Hauck.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 718-728, 5 ref.

Descriptors: *Agriculture, *Developing countries, *Erosion control, *Soil erosion, *World Soil Charter, Food and Agriculture Organization, Future planning, Management planning, Policy making, United Nations.

Despite major technological advances in agricultural production, millions of people in the world still starve or do not have enough to eat. Among the causes of this paradox is the rate at which the productive capacity of land and the quantity and quality of water resources have been or are still being reduced or destroyed by soil erosion and other forms of land degradation. Projections of future population growth suggest that by the time the world comes reasonably close to population stability, the demand for food and agricultural products could be three times its present level. Sufficient land resources to meet this need appear to be available if all cultivable land is used in an optimum way and there is unrestricted movement of produce. However, a major problem is that large areas of the world's agricultural land is being degraded by severe soil erosion and other problems. Historically, between 5 and 7 million ha of land have been lost annually through soil degradation, necessitating bringing into production an additional 200 million ha just to compensate for losses of productive land a current rates. The World Soil Charter, which was adopted by the 21st annual conference of the United Nations Food and Agriculture Organization in 1981, outlines a number of principles and guidelines that should provide the necessary framework for sound policy decisions and the development of national programs that will lead to the rational use of land resources and the control of soil degradation. In FAO's view, stopping or reversing the land degradation process is matter of the utmost urgency. The immediate task is to increase awareness among governments, policy makers, planners, and farmers of the problems and consequences of soil erosion. (See also W91-03117) (Rochester-PTT)
W91-03175

CITANDUY PROJECT IN JAVA: TOWARD A NEW APPROACH TO WATERSHED STABILIZATION AND DEVELOPMENT.
Agency for International Development, Karachi (Pakistan).
E. M. Barrau, and K. Djati.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 729-739.

Descriptors: *Agricultural runoff, *Dry farming, *Erosion control, *Indonesia, *Irrigation, *Soil erosion, *Watershed protection, Citanduy Project, Economic aspects, Extension programs, Social aspects, Terraces.

Watersheds of Java, Bali, and Madura (Indonesia) support dense populations (e.g., 600-1000 persons/sq km in Java, with less than 25% of the land under forest or other permanent cover). Several factors contribute to high rates of erosion and an agricultural situation that is not conducive to alleviating the erosion problem. These include: runoff from dryland farms, lack of water for irrigation of terraces, poor economic conditions at the farm level, limited sources of seed and credit, limitations on scope of technology transfer programs, limited research programs, unprofitability of conservation efforts due to existing low productivity of dryland farms, and inadequacy of extension efforts. Grass and forage programs have the potential to help control erosion, but availability of suitable species is limited and knowledge about their proper management has been slow to spread among farmers. The Citanduy II project covers two watersheds, the Citanduy (350,000 ha) and the Segara Anakan (96,000 ha). The project has three main components: (1) upper watershed development to provide a package of upland conservation and production technology to upland farmers, (2) development of irrigation systems to rehabilitate upper Citanduy irrigation systems and their management, and (3) local development planning and management to help district government personnel. The objective of the watershed stabilization and development program is not just to build bench terraces on the hillsides, but to prove to the dryland farmers that with the proper techniques and additional resources (high-yielding seeds, fertilizers, forage, and livestock) their dryland bench terraces can be as productive as their irrigated bench terraces. Only then will the farmers build and maintain dryland terraces as well as irrigated terraces. Achieving this result depends on the ability of the government to make readily available the supplies and other necessary resources and to deliver, disseminate, and coordinate these resources. (See also W91-03117) (Rochester-PTT)
W91-03176

ECOSYSTEM APPROACH TO SOIL CONSERVATION.
Bern Univ. (Switzerland). Geographisches Inst.
H. Hurni.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 759-771, 6 fig, 2 tab, 20 ref.

Descriptors: *Ecosystems, *Erosion control, *Public policy, *Social aspects, *Soil conservation, *Watershed management, Case studies, Ethiopia, Geoecosystem approach, Mountains, Nepal, Thailand.

Although the reasons for soil erosion are relatively clear (population growth, deforestation, and the resulting changes in land use), programs designed to solve these problems frequently fail because conservation programs and land use plans fail to spread from a pilot project area to its surrounding area. Success often comes because bottlenecks (hindrances to the conservation process) are de-

tected and bypassed. A systematic guide is presented here for detecting such bottlenecks. The approach was developed from findings of the recently launched UNESCO Man and the Biosphere programs. A geoecosystem approach to soil conservation consists of recognizing the elements in each of four complexes, the natural complex, the land use complex, the human complex, and the external complex, and then determining all possible relations among the complexes. For identified negative processes causing damage, natural and technological mitigating processes should be identified. The use of the geoecosystem approach can be seen in analyses of three case studies: the Ethiopian highlands, the Nepalese middle mountains, and the northern Thai mountains. For each case, natural conditions, land use, man's role, and interrelations have been identified. Bottlenecks blocking conservation progress are apparent for each case. Examples of bottlenecks include: low recognition of the problem among peasants and lack of training in terracing techniques (Ethiopia), lack of cooperation among ethnic groups and almost uncontrollable high natural erosion rates (Nepal), and immigration-induced changes in traditional land use systems (Thailand). Through an integrated, geoecosystem approach, the factors and relations revealing bottlenecks in soil conservation can be assessed qualitatively, sometimes subjectively or quantitatively. The approach also can be used to find methods of by-passing individual problems. (See also W91-03117) (Rochester-PTT)
W91-03177

SEDIMENT CONTROL BY SUBMERGED VANES: DESIGN BASIS.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2J.
W91-03208

SCUDDER'S POND RESTORATION PROJECT FOR VILLAGE OF SEA CLIFF AND TOWN OF OYSTER BAY, NASSAU COUNTY, NEW YORK.
Envirodyne Engineers, Inc., New York.
For primary bibliographic entry see Field 5G.
W91-03218

CONTROLLING SOIL EROSION IN THE ILLINOIS RIVER BASIN.
Illinois Dept. of Agriculture, Springfield. Div. of Natural Resources.
R. W. Nichols.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 28-35, 2 tab, 1 ref.

Descriptors: *Erosion control, *Illinois, *Illinois River Basin, *Management planning, *Resources management, *Soil erosion, Erosion, Illinois River, Land use, Sedimentation, Water conservation.

The Illinois River Basin encompasses nineteen subbasin areas containing a combined total of 15,646,100 acres. Soil erosion and deposition of sediment into surface waters is a natural process that has been accelerated by land altering changes brought about by man. Intensive agriculture, land clearing, urban construction, drainage of wetlands, levee construction and alteration of stream segments in the Illinois River drainage basin have significantly increased the rate of erosion and the amount of sediment entering stream tributaries, the Illinois River and its backwater lakes and sloughs. Soil and Water Conservation Districts (SWCDs) have intensified their efforts to protect erosion prone lands. As a part of their efforts, each of the state's 98 SWCDs undertook the task of identifying the status of the resource base within their respective boundaries. Six districts surrounding Peoria Lake were selected for a demonstration project involving protection of the resource base through the application of standard soil conservation practice while at the same time implementing nontraditional/innovative techniques for controlling the flow of sediment into the lake as well as stabilizing the streams that are importing that sediment. The success of the demonstration project will depend on the interest and desires of those affected. Accordingly, the following recommendations are provided for consideration: utilize the existing technical, financial, and educational assistance mechanisms; organize local resource planning committees in each small hydrologic unit within the larger river basin; concentrate soil conservation efforts in the watershed areas above and surrounding Peoria Lake; give highest priority for erosion control to steep slopes and areas with excessive streambank erosion; encourage the use of federal Conservation Reserve Practices (CRP) such as tree planting, establishing permanent vegetative cover, and filter strips on highly-erodible ground; expand streambank stabilization projects on tributaries; encourage voluntary soil conservation practices by landowners, and; designate the Illinois River Soil Conservation Task Force as the local organization for coordination of resource planning. (See also W91-03608) (Lantz-PTT)
W91-03611

ILLINOIS RIVER AND PEORIA LAKES: IT'S TIME TO ACT.
Caterpillar Tractor Co., Peoria, IL.
For primary bibliographic entry see Field 6A.
W91-03621

ILLINOIS RIVER SOIL CONSERVATION TASK FORCE.
D. Condit.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 106-109.

Descriptors: *Erosion control, *Illinois, *Illinois River, *Project planning, *Resources management, *Soil conservation, Economic aspects, Environmental protection, Institutions, Public policy, Soil erosion, State jurisdiction.

The Illinois River Soil Conservation Task Force (IRSCTF) was formed in June 1985. This not for profit 501C3 Corporation was made up of elected Soil and Water Conservation District directors from 7 soil and water districts, as well as agency, industry and organizational advisors. The Task Force operates on grant monies; the project coordinators and construction supervisors are self-employed consultants to the Task Force. Project Chance people are used for the labor force. As the Task Force completes its fourth project this fall, with the low-cost stabilization of gullies and streambanks, their desire would be to have landowners become involved in their projects. As an action group, the Task Force has the districts working together to build support for a combined local, state and federal effort aimed at reducing farmland erosion to the lowest practical levels. (See W91-03608) (Lantz-PTT)
W91-03622

STREAM BANK STABILIZATION AND THE ILLINOIS RIVER SOIL CONSERVATION TASK FORCE.
Illinois River Soil Conservation Task Force, Eureka, IL.
D. Condit.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 110-132, 12 fig, 3 tab, append.

Descriptors: *Bank protection, *Illinois, *Illinois River Basin, *Institutions, *Resources management, *Soil conservation, *Stream banks, Conservation, Illinois River, Local governments, Peoria Lake, State jurisdiction, Watershed management.

The Illinois River Soil Conservation Task Force provides an action program to stimulate, accelerate and implement conservation practices on the Illinois River watershed. In June 1985, the task force was formally organized by seven Soil and Water Conservation Districts from watersheds along the Peoria Pool segment of the Illinois River. This action group is working together to build support for a combined local, federal and state effort, which will reduce farmland erosion to the lowest practical level. The Task Force supports traditionally funded erosion control practices as conservation tillage and terraces. The task force also supports the development and funding of alternative erosion control methods such as low cost streambank and ravine stabilization practices. The Task Force supports alternative erosion practices where massive streambank or gully erosion sites are transporting high percentages of such farmland erosion to Peoria Lake. Streambank stabilization practices were applied first near Galesburg by the Department of Conservation. The Galesburg Watershed had demonstrated the high sediment yields resulting from streambank erosion. With ENR funding and technical assistance from the Soil Conservation Service, the Task Force has applied the vegetative stream stabilization techniques at additional field conservation trial sites on Richland, Senachawine, and Partridge Creeks, which flow into Peoria Lake. Labor for application of conservation practices was volunteers from the Project Change program of the Illinois Department of Public Aid. Over 20 of the volunteers have found employment after demonstrating and ability to work under difficult conditions. (See also W91-03608) (Lantz-PTT)
W91-03623

SEDIMENT MANAGEMENT.
Illinois Univ., Urbana. Water Resources Center.
G. Stout.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 147-149.

Descriptors: *Illinois, *Organic matter, *Resources management, *Sediment load, Agriculture, Crop production, Crop yield, Economic aspects, Fertilizers, Land use, Waste disposal.

The concept of sediment as a potential resource is examined. The organic rich material may be used to rebuild soil or add depth to existing farm land, enhancing agricultural production. Sediment may also be used to build roads, for landscaping, or as a soil enrichment for lawns. In the late 1970s, a quantitative demonstration project was executed by the Water Resource Center and the University of Illinois Agricultural Engineering Department at Lake Paradise; 2100 cu yds of sediment were pumped one mile from the lake to a site which was considered typical of the watershed near the lake. Lagoons were built to collect three feet of sediment with a subsurface drainage system. The land was leveled off the next year and returned to crop production. Corn yields exceeded 25% from previous years. Test plots showed that 18 inches of sediment increased yields by 40%. The study showed that while returns from corn production was low based on 1982 prices, there was a predicted $100/acre increase in returns for the test plots with 18 inch sediment treatments compared to the zero sediment treatment. The predicted increase was due to the increased yields and the lower fertilizer requirements of the test plots. (See also W91-03608) (Lantz-PTT)
W91-03627

EROSION CONTROL IN THE ILLINOIS RIVER BASIN PAST, PRESENT, AND FUTURE.
Soil Conservation Service, Champaign, IL.
G. N. Parker.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 168-170.

Descriptors: *Erosion control, *Illinois, *Illinois River Basin, *Soil conservation, Agriculture,

Cropping, Erosion, Forests, Illinois River, Land use, Management planning, Peoria Lakes, Public participation, Resources management, Soil erosion, Tillage, Urbanization.

The Soil Conservation Service recently completed a River Basin Study of the Illinois River from Peoria to Lasalle. Of the approximately 1 million acres in this drainage area, 87.5% are cropland, 10% are woodland, and the remaining acres are pastureland and various urban land uses. Approximately 55% of the croplands' erosion rates are < 5 tons/acre/year. That leaves 400,000 acres of cropland eroding at rates in excess of 5 tons/acre/year. 1300 landowners install conservation practices on 160,000 acres annually, reducing erosion by 750,000 tons. At this rate all of the cropland will be treated within 5 years. Since erosion control programs have been on-going for many years, there should be dramatic reductions seen in sediment rates. Erosion control programs need to be targeted to the most critical subwatersheds in order to achieve significant reductions in sediment delivery. An effective sediment reduction program must include both a sediment trapping element, as well as an erosion reduction element. Some suggestions for future land treatment programs in the Peoria Lake Basin are: (1) Concentrate soil conservation efforts in the watershed areas above the surrounding Peoria Lakes; (2) Actively encourage and promote the adoption of cropping systems which reduce tillage and increase crop residues; (3) In priority watersheds, employ large sediment basins and man-made wetlands to trap sediment before it reaches the Lake; (4) Utilize a coordinated, multicounty approach to target efforts at the most critical sites; (5) Erosion control on some steeper cropland adjacent to streams and near the lake can only be achieved economically by removing that land from production and establishing permanent cover; and (6) Organize citizen-based steering committees in each subwater shed to develop an action plan specific to each subwatershed. (See also W91-03608) (Lantz-PTT)
W91-03630

LAND HUSBANDRY: A FRAMEWORK FOR SOIL AND WATER CONSERVATION.
T. F. Shaxson, N. W. Hudson, D. W. Sanders, E. Roose, and W. C. Moldenhauer.
Available from the Soil and Water Conservation Society, Ankeny, Iowa. Price: $12.00. 1989. 60p, 20 fig, 2 tab.

Descriptors: *Developing countries, *Erosion control, *Land management, *Soil erosion, *Water conservation, Agriculture, Cropping, Erosion, Farming, Runoff, Social aspects, Soil conservation.

Where steep slopes must be farmed for food, feed, or fiber production, soil erosion results in both on-site and off-site impacts. There are many cases where all of the productive soil has washed from fields or where expensive reservoirs have filled rapidly with sediment. These erosion problems continue in spite of expensive control programs and interventions. While recognizing the fact that the supplementary need for structural measures must not be forgotten or underrated, it is much more effective to develop a plan or strategy for increased production and efficiency with the farmer, using structural measures, if necessary, to complement an effective system of land husbandry. Better management of crops, pastures, forests, and soil retains more water for productive use by plants and for maintaining streamflow. Lowering raindrop splash and runoff reduces the amount of soil that is dislocated and transported away from where it is needed--around plant roots. To achieve effective soil and water conservation through proper land husbandry, three basic ideas are important: (1) farmers--it is imperative to identify, engage, develop, and encourage the enthusiasm of individual farmers and communities in plant production activities; (2) husbandry--the more fragile and erosion-prone an area is, the more urgent it is to give attention to producing, improving, and maintaining dense and long-lasting soil cover with useful plants and their residues; and (3) runoff--it flowing runoff is unavoidable, arrange for its safe disposal without causing erosion damage. While is appeared that a publication was justified to elaborate these principles, it was also decided that this publication must be broad enough to apply worldwide but not so general as to be of little use. Therefore, this publication is meant to provide a framework into which site-specific technical details can be fitted. (Lantz-PTT)
W91-03652

IMPACT OF RISK AND PLANNING HORIZONS ON THE SELECTION OF SOIL CONSERVATION MANAGEMENT SYSTEMS.
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
R. R. Venkataraman, and G. V. Johnson.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 107-116, 4 tab, 8 ref.

Descriptors: *Environmental policy, *Model studies, *Nonpoint pollution sources, *Planning, *Risks, *Soil conservation, *Soil management, *Water resources management, Agriculture, Computer models, Crop production, Illinois, Management planning, Soil erosion, Water quality control, Water quality management.

Soil conservation issues resurfaced in the U.S. during the 1970s when crop acreage expanded by more than 120 percent to meet a 132 percent rise in agricultural exports. This large, rapid expansion in cropland acreage generated concern that an increase in soil erosion might impair the nation's long term food producing capability. Accelerated soil erosion exerts a great influence on productivity, and it detrimentally affects water quality in a number of ways. The interrelationship between planning horizons and selection of optimal soil conservation management systems was examined at the micro level. An investigation is planned to determine the extent to which weather, yield, product price, and soil loss uncertainties would affect the adoption of these systems in the short and long run. The effect of taxes and subsidies in the selection of optimal soil conservation management systems will also be considered. The model employed for this study will select those management systems that maximize net returns while reducing soil erosion. Since soil erosion is directly related to water quality, the management systems selected by the model can be considered as those improving water quality by reducing soil erosion. Results of preliminary tests of the model using data from southern Illinois indicate that incorporation of risk in soil conservation decision would influence the selection of soil conservation management systems. The model is essentially a static one and ignores the dynamics of time. Future research should focus on expanding this model to incorporate the dynamic effects (for example, multiperiod optimization with a stochastic soil loss constraint) considering all the uncertainties involved. (See also W91-03704) (Author's abstract)
W91-03716

NONPOINT SOURCE REGULATION--A WATERSHED APPROACH.
Environmental Protection Agency, Chicago, IL. Region V.
T. E. Davenport.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 117-121, 3 ref.

Descriptors: *Nonpoint pollution sources, *Regulations, *Water policy, *Water pollution control, *Water quality management, *Water resources management, *Watershed management, Clean Water Act, Compliance, Law enforcement, Management planning, Waste load allocation, Wastewater disposal, Water Quality Act, Water quality standards.

For some waterbodies, nonpoint source pollution (NPS) prevents attainment of water quality standards and impairs designated uses. The traditional voluntary approach to NPS management has not been uniformly successful in controlling NPSs and some NPS problems still needed to be controlled to attain the goals of the Clean Water Act (CWA). The recently-passed Water Quality Act of 1987 creates a National Nonpoint Source Pollution Control Program, that mandates control of NPS pollution on a watershed basis to the maximum extent possible. Presently, technology exists to control point sources on a watershed basis. The present approach is to require compliance with water quality standards and application of a waste load allocation. The waste load allocation process apportions the assimilative capacity of the waterbody between dischargers and guarantees a margin of safety to protect the waterbody. Unlike point source controls, the Agency does not have direct regulatory or enforcement authority to ensure implementation or maintenance of nonpoint source controls. By combining the point source control approach with a watershed management planning and implementation program that can be tied to other regulatory mechanisms such as the conservation plans under the 1985 Farm Bill and Water Quality Management Plans required under Section 303 of CWA or National Pollution Discharge Elimination Permit System and 404 permit NPS controls may be imposed in some instances akin to other CWA regulatory requirements. (See also W91-03704) (Author's abstract)
W91-03717

INTEGRATED EXPERIENCE--THE MILWAUKEE RIVER EAST-WEST BRANCH WATERSHED RESOURCE MANAGEMENT PLAN.
Wisconsin Dept. of Natural Resources, Milwaukee.
S. L. Gayan, and J. D'Antuono.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 165-172, 1 fig, 5 ref.

Descriptors: *Interagency cooperation, *Milwaukee River, *Nonpoint pollution sources, *Water pollution control, *Water resources management, *Watershed management, Conservation, Environmental policy, Governmental interrelations, Headwaters, Natural resources.

The Milwaukee River Program is an example of how the Wisconsin Department of Natural Resources (WDNR) is responding to meet the challenges of both protecting and managing natural resources in southeastern Wisconsin. This approach uses a complex interdisciplinary and interagency coordination effort to ensure that the conservation, enhancement, management, and use of the natural resources in the Basin are achieved in the most effective manner possible. The East-West Branch is the largest and most complex of the Milwaukee River basin's five major drainage areas. Planning efforts in this watershed demonstrate how nonpoint pollution sources can be controlled more effectively using integrated resource management, and the reduction of pollutants entering the headwaters of the river system will benefit not only those smaller streams directly impacted, but also will result in improved aquatic resources downstream. The integrated resource management concept uses the WDNR Nonpoint Source Pollution Control Program as the foundation for initiating and coordinating the efforts of 11 WDNR program areas, units and agencies of government, agricultural interests, and environmental organizations on a watershed basis. The involvement of these program areas, units and agencies of government, and special interest groups is made possible through advisory, technical, and informational committees and subcommittees. (See also W91-03704) (Author's abstract)
W91-03723

MODELING NONPOINT POLLUTION AT THE WATERSHED LEVEL WITH THE AID OF A GEOGRAPHIC INFORMATION SYSTEM.
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
B. M. Evans, and D. A. Miller.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Pro-

ceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 283-291, 3 fig, 1 tab, 5 ref.

Descriptors: *Computer models, *Geographic information systems, *Model studies, *Nonpoint pollution sources, *Path of pollutants, *Water quality management, Agriculture, Cost-benefit analysis, Demonstration programs, Microcomputers, Pennsylvania, Simulation analysis, Water policy, Water pollution control, Water pollution sources, Water resources management, Watershed management.

In a recently completed demonstration project, an integrated approach coupling a computer simulation model with a geographic information system (GIS) was used to assess agricultural nonpoint source (NPS) pollution problems at the watershed level in Pennsylvania. A microcomputer-based GIS was used to create a high-resolution digital geographic database containing data on over a dozen spatially distributed watershed variables. The GIS was also used to compute the average values for each watershed variable (e.g., curve number, slope, soil erodibility) for subareas within the watershed. This data was subsequently digitally reformatted for direct input to the simulation model. The simulation model used was AGNPS (Agricultural Non-Point Source) which is considered by many to be one of the most comprehensive and cost-effective watershed-based NPS models currently available. Based on estimates for conducting AGNPS analyses of watersheds of varying sizes, it was predicted that this particular study would have cost approximately $14,400 using the conventional approach, in contrast with half that amount for the study using the GIS-based approach (including the cost for developing parameter overlay capabilities). This type of cost-benefit ratio would almost surely increase as the size of watersheds being evaluated increases. Future plans for improving the program include providing the capability for assigning values for parameters so that they would not have to be manually entered, and developing new algorithms for more precisely quantifying slope gradient and field slope length automatically. (See also W91-03704) (Fish-PTT)
W91-03734

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

STATUS OF BIOASSESSMENT ACTIVITIES IN THE U.S. FISH AND WILDLIFE SERVICE.
Fish and Wildlife Service, Washington, DC. Div. of Environmental Contaminants.
D. W. Steffeck, and J. A. Blankenship.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 3A-17--3A-29, 1 tab, 14 ref.

Descriptors: *Bioassay, *Bioindicators, *Environmental effects, *Monitoring, *Water management, *Water pollution effects, Bioaccumulation, Ecosystems, Fish, Fish and Wildlife Service, Wildlife.

The US Fish and Wildlife Service (USFWS) is faced with a multitude of contaminant problems that effect fish and wildlife sources throughout the US. In order to identify and mitigate contaminant problems, the USFWS monitors the health of the nation's fish and wildlife resources through a variety of methods. One such method, the National Contaminant Biomonitoring Program (NCBP) is designed to monitor trends in contaminant levels in fish and wildlife species over time and according to geographic region. In addition, various site specific studies are initiated each year to identify and define the extent of contaminant problems and formulate solutions. Bioassessment techniques are rapidly becoming the main focus of many of these studies, replacing the purely chemical basis of contaminant analysis so prevalent in recent years. Past and ongoing laboratory and field research by the USFWS National Research Centers has provided a variety of approaches for identifying and evaluating contaminant problems in fish and wildlife, including on-site and laboratory bioassays, the use of gross biological responses (tumors, spinal deformities, external lesions), physiological and/or biochemical responses, contaminant bioaccumulation, and changes in community composition. New techniques are being developed, as are methods to evaluate adverse impacts of new generation chemicals. (See also W91-03032) (Author's abstract)
W91-03045

HETEROTROPHIC PLATE COUNT BACTERIA IN POTABLE WATER MONITORING METHODS AND APPLICATIONS.
Environmental Protection Agency, Cincinnati, OH. Microbiological Treatment Branch.
For primary bibliographic entry see Field 5F.
W91-03224

40 CFR 265 INTERIM-STATUS GROUNDWATER MONITORING PLAN FOR THE 2101-M POND.
Battelle Pacific Northwest Labs., Richland, WA.
M. A. Chamness, S. P. Luttrell, and S. Dudziak.
Available from the National Technical Information Service, Springfield, Virginia 22161, as DE89-010565. Price codes: A07 in paper copy, A01 in microfiche. Report no. PNL--6851, March 1989. 152 p, 12 fig, 9 tab, 31 ref, 5 append.

Descriptors: *Groundwater pollution, *Hanford, *Monitoring, *Monitoring wells, *Path of pollutants, *Ponds, *Radioactive wastes, *Sampling, Evaluation, Groundwater movement, Hazard assessment, Resource Conservation and Recovery Act, Water analysis.

A groundwater monitoring plan has been developed for the 2101-M pond, located in the southwestern part of the 200-East Area on the Hanford Site in southcentral Washington State. It has been determined that hazardous materials may have been discharged to the pond. Installation of an interim-status groundwater monitoring system is required under the Resource Conservation and Recovery Act to determine if hazardous chemicals are moving out of the pond. Phase I of the plan is an indicator evaluation groundwater monitoring program, which involves hydrogeologic characterization, a schedule of characterization and well installation, sampling and analysis of indicator evaluation monitoring data, and the associated reports. Phase II is the initiation of an assessment-level monitoring program, encompassing initiation criteria, an assessment-level monitoring program (nature and extent of contamination, rate of movement, additional well installations, additional field and laboratory testing, and modeling), and a plan for continued analysis and evaluation (review of methods and procedures, review of sampling parameters and frequency, and notification and reports). Four new wells are planned, one upgradient and three downgradient. (Fish-PTT)
W91-03238

RCRA GROUND-WATER MONITORING PROJECTS FOR HANFORD FACILITIES: ANNUAL PROGRESS REPORT FOR 1988.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5G.
W91-03242

STEAM DISTILLATION WITH RESIN EXTRACTION FOR ISOLATION AND CONCENTRATION OF ORGANIC COMPOUNDS FROM AQUEOUS SAMPLES.
Ames Lab., IA.
For primary bibliographic entry see Field 2K.
W91-03290

SOLID-PHASE EXTRACTION FOR TOXICITY REDUCTION EVALUATIONS OF INDUSTRIAL WASTEWATER EFFLUENTS.
West Point-Pepperell Research Center, Valley, AL.
For primary bibliographic entry see Field 5D.
W91-03291

SOLID-PHASE EXTRACTION OF HERBICIDES FROM WELL WATER FOR DETERMINATION BY GAS CHROMATOGRAPHY-MASS SPECTROMETRY.
Monsanto Agricultural Products Co., St. Louis, MO.
S. A. Schuette, R. G. Smith, L. R. Holden, and J. A. Graham.
Analytica Chimica Acta ACACAM, Vol. 236, No. 1, p 141-144, September 1990. 1 fig, 1 tab, 4 ref.

Descriptors: *Gas chromatography, *Groundwater pollution, *Mass spectrometry, *Pollutant identification, *Separation techniques, *Triazine herbicides, *Water analysis, Alachlor, Atrazine, Cyanazine, Metolachlor, Simazine.

A simple, rapid method for isolating herbicides from well water was developed using disposable octadecyl (C18) solid-phase extraction columns. Deuterium-labeled internal standards were used to compensate for any losses that may occur during sample preparation owing to matrix effects. Detection by capillary gas chromatography-mass spectrometry in the selected ion monitoring mode minimized the frequency of false-positive results. The accuracy of the method was + or -5% at concentrations >0.20 micrograms/L for four of the five herbicides studied (alachlor, metolachlor, atrazine, and simazine). Cyanazine exhibited slightly poorer accuracy and substantially greater variability, particularly at the lower concentrations, probably due to its poor chromatographic properties and detector response. (Author's abstract)
W91-03292

DETERMINATION OF URANIUM IN AN ANALYTICAL CHEMISTRY LABORATORY.
Environmental Monitoring Systems Lab., Las Vegas, NV.
For primary bibliographic entry see Field 7B.
W91-03376

SETTING UP A LABORATORY FOR RADON IN WATER MEASUREMENTS.
Maine Univ. at Orono. Dept. of Physics and Astronomy.
C. T. Hess, and S. M. Beasley.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 193-202. 2 fig, 1 tab, 6 ref.

Descriptors: *Analytical techniques, *Laboratory equipment, *Pollutant identification, *Radioisotopes, *Radon, *Water analysis, Air pollution, Quantitative analysis, Radiation, Research facilities, Water quality control.

The steps required to measure radon in water using liquid scintillation counting are presented. The steps, which are explained in detail, are: sampling, scintillation counter operation, analysis of the counts, calculation of the concentration, and the preparation of standards. The process of testing water for radon concentrations can be summarized into three steps: (1) preparation of water sample vials; (2) counting the activity of the vials using a liquid scintillation counter; and (3) converting the counts per minute into picocuries per liter. The operation of the liquid scintillation counter involves several steps, which include: calibrating the gain, setting up the discrimination windows, adjusting the time of counting, loading a set of samples and standards, and calculating and reporting the results. It is concluded that the process of testing water for radon gas is an effective means of determining if the water poses a significant source of indoor air radon and a significant health threat. A thorough understanding of radon gas, its progenies' health hazards, and methods of infiltration facilitate a more accurate analysis of individual homes. (See also W91-03366) (Agostine-PTT)
W91-03378

ANALYTICAL METHODOLOGY FOR RADIUM IN FOOD AND WATER.
Food and Drug Administration, Winchester, MA. Winchester Engineering and Analytical Center.
E. J. Baratta.

IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 203-212. 3 tab, 42 ref.

Descriptors: *Analytical methods, *Analytical techniques, *Chemical analysis, *Drinking water, *Foods, *Pollutant identification, *Radiochemical analysis, *Radium, *Water analysis, Laboratory methods, Quality control, Radioisotopes, Water quality standards.

The hazards associated with radium-226 and radium-228 have been well studied and documented. Analysis at the levels set by the Environmental Protection Agency (EPA) for these two isotopes in drinking water should present no analytical problems. The methods for radium-226 by total radium and emanation have been collaboratively studied and published in the ALPHA Standard Methods. The method of Krieger for radium-228, although it has not been collaboratively tested, has the tentative approval of the American Public Health Association (ALPHA) Standard Methods and was recommended by the National Institute for Science and Technology (formerly the National Bureau of Standards). In this method the radium is precipitated using barium and lead carriers, then purified and the actinium-228 allowed to ingrow. It is separated using a yttrium carrier and the actinium-228 is beta counted. Other methods could also be used. It should be noted that the EPA's Quality Assurance Program should be used to document that the methods being used are performing adequately. (See also W91-03366) (Agostine-PTT)
W91-03379

PRECONCENTRATION OF IRON BY COMPLEXATION AND ULTRAFILTRATION.
Turin Univ. (Italy). Dipt. di Chimica Analitica.
For primary bibliographic entry see Field 7B.
W91-03411

HIGH-PERFORMANCE LIQUID CHROMATOGRAPHIC APPROACH FOR MONITORING ETHOFUMESATE IN PLANT, SOIL AND WATER.
Jordan Univ., Amman. Analytical Chemistry Labs.
M. A. Alawi.
Analytical Letters ANALBP, Vol. 23, No. 9, p 1695-1709, September 1990. 3 fig, 3 tab, 5 ref.

Descriptors: *Agricultural chemicals, *Chemical analysis, *Herbicides, *High performance liquid chromatography, *Pollutant identification, *Water analysis, Beets, Detection limits, Groundwater pollution, Soil contamination.

Ethofumesate is a selective herbicide used for beet and grass crops. A simple quantitative high performance liquid chromatography (HPLC) ultraviolet (uv) method for the analysis of ethofumesate in fodder beet, soil, and water samples has been developed. This method is based on a simple extraction step, gel-chromatographic and/or mini-silica gel column cleanup step and a separation step on a reversed phase column with uv-detection. The method is sensitive down to 0.01 mg/kg in water and 0.05 mg/kg in plants and soil. This approach shows recoveries between 90% and 110% in almost all matrices. The advantages of this approach are the simple extraction step and the clean extraction residue after the gel-chromatographic and/or silica gel cleanup steps. These advantages combined with the specific detection at 280 nm render this method suitable for routine analysis of ethofumesate. Preliminary tests show that this method is also applicable for the analysis of ethofumesate in other plant materials. (Author's abstract)
W91-03412

MEMBRANE/GAS CHROMATOGRAPHIC SYSTEM FOR AUTOMATED EXTRACTION AND DETERMINATION OF TRACE ORGANICS IN AQUEOUS SAMPLES.
Dow Chemical Co., Midland, MI. Analytical Labs.
R. G. Melcher, and P. L. Morabito.
Analytical Chemistry ANCHAM, Vol. 62, No. 20, p 2183-2188, October 15, 1990. 7 fig, 4 tab, 14 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Gas chromatography, *Membranes, *Organic compounds, *Pollutant identification, *Water analysis, Chlorinated hydrocarbons, Chromatography, Concentration factors, Detection limits, Organic solvents, Pesticides, Sample matrix, Standards.

A new automated extraction analysis system, which combines membrane cell technology with a pneumatically operated pressurized rotary gas chromatographic injection valve, was developed and tested. The system was evaluated by using chlorinated aromatic compounds and pesticides as test sample mixtures. These compounds were successfully extracted and determined in water and organic/water type matrices in part-per-trillion to part-per-billion range. Two modes of membrane operation were demonstrated: the continuous-flow mode, which produces concentration factors of approximately 3 to 5; and the stop-flow mode, which produces concentration factors in the 50-200 range. The effects of adding common organic solvents to the samples were unexpected increases in extraction efficiency. To reduce sample matrix effects, an internal standard procedure was evaluated. The internal standard, which was added to the sample, was extracted with the analytes of interest to help compensate for matrix effects. The accuracy and precision were significantly improved over the use of an external standard analysis; however, the internal standard analysis was unable to completely compensate when high percent levels of organic solvents were added to the sample. Membrane cell technology with a pneumatically operated pressurized rotary gas chromatographic injection valve has potential both for use in sophisticated laboratory systems for automated extraction and analysis and also for simplified, dedicated systems for on-line analyzers. (Author's abstract)
W91-03436

SOIL-GAS SURVEYING FOR SUBSURFACE GASOLINE CONTAMINATION USING TOTAL ORGANIC VAPOR DETECTION INSTRUMENTS: PART II. FIELD EXPERIMENTATION.
Connecticut Univ., Storrs. Dept. of Geology and Geophysics.
G. A. Robbins, B. G. Deyo, M. R. Temple, J. D. Stuart, and M. J. Lacy.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 4, p 110-117, Fall 1990. 8 figs, 4 tab, 6 ref. Environmental Monitoring Systems Laboratory and U.S. EPA Cooperative Agreement Grant CR-814542-01.

Descriptors: *Analytical methods, *Gasoline, *Groundwater pollution, *Hydrocarbons, *Measuring instruments, *Pollutant identification, *Soil contamination, Field tests, Instrumentation, Organic pollutants, Soil gases, Total organic vapor detection.

Field studies were performed at a service station to illustrate the responses of total organic vapor detection instruments in soil-gas surveying under field conditions and to demonstrate the use of the serial dilution technique. Field measurements confirmed that instrument responses were influenced by the relative humidity, low oxygen content, high carbon dioxide level, and relative abundance of detectable constituents of the soil gas. The distribution of organic vapors as determined by sampling soil-gas probes directly or undiluted Tedlar bags did not delineate the area of known contamination. Also, poor correlation was obtained between field instrument readings and laboratory measurements. Application of the serial dilution technique resulted in improved correlation between field and laboratory soil-gas measurements as well as the delineation of the area of known gasoline leakage. Response factor calculations, performed using field data and theoretical and laboratory relations, closely approximated observed instrument responses. The results of the field study demonstrated that the casual use of total organic vapor detection instruments in soil-gas surveying can result in misleading information on the presence, location, and extent of subsurface contamination. The application of these instruments can be significantly improved through performing serial dilutions. (See also W91-00368) (Author's abstract)
W91-03448

PRELIMINARY DELINEATION OF CONTAMINATED WATER-BEARING FRACTURES INTERSECTED BY OPEN-HOLE BEDROCK WELLS.
Geological Survey, Albany, NY.
For primary bibliographic entry see Field 5B.
W91-03449

DETERMINATION OF TOTAL PHOSPHORUS IN WATERS WITH AMPEROMETRIC DETECTION BY COUPLING OF FLOW-INJECTION ANALYSIS WITH CONTINUOUS MICROWAVE OVEN DIGESTION.
Technische Univ. Clausthal, Clausthal-Zellerfeld (Germany, F.R.). Anorganisch-Chemisches Inst.
S. Hinkamp, and G. Schwedt.
Analytica Chimica Acta ACACAM, Vol. 236, No. 2, p 345-350, September 17, 1990. 3 fig, 3 tab, 14 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Laboratory methods, *Microwaves, *Phosphorus, *Pollutant identification, *Water analysis, Analytical techniques, Digestion, Hydrogen ion concentration, Microwave digestion, Orthophosphates.

Phosphorus appears in ground, surface and waste waters in various concentrations either in dissolved or undissolved forms, or as organically bound compounds. For the continuous determination of total phosphorus, a combination of a decomposition unit and flow-injection analysis are necessary. Microwave sample digestion has been used for the rapid determination of numerous elements in biological and geological matrices. A continuous microwave oven decomposition with subsequent amperometric detection of orthophosphate was used to determine total phosphorus in water. The percentage digestion was examined for two different decomposition reagents and by varying the pH of the carrier and the length and diameter of the digestion coil. With potassium peroxodisulfate decomposition, the recoveries of phosphorus varied from 91-100% for organic phosphorus compounds. With perchloric acid decomposition, the recoveries varied from 60-70% for inorganic polyphosphates. Calibration graphs were linear for up to 30 mg P/L, the determination limit was 0.1 mg P/L and the precision of the method was 3% (relative standard deviation) ($n = 5$) at 5 mg P/L. The sampling rate was 20 samples/hour. Good recoveries of phosphorus after addition to domestic waste were obtained. (Mertz-PTT)
W91-03458

FIELD METHOD FOR DETERMINATION OF TRACES OF THIOLS IN NATURAL WATERS.
Rosenstiel School of Marine and Atmospheric Science, Miami, FL. Div. of Marine and Atmospheric Chemistry.
A. Vairavamurthy, and K. Mopper.
Analytica Chimica Acta ACACAM, Vol. 236, No. 2, p 363-370, September 17, 1990. 5 fig, 31 ref. Office of Naval Research grant 0014-84-K-0733 and National Science Foundation grants OCE 8516020 and OCE 8613940.

Descriptors: *Analytical methods, *Chemical analysis, *Field tests, *Pollutant identification, *Pore water, *Thiols, *Water analysis, Analytical techniques, Biscayne Bay, Black Sea, Liquid chromatography, Organic compounds, Sample preparation.

Derivatization with 2,2'-dithiobis(5-nitropyridine) (DTNP) was used to stabilize thiols in field samples and to determine these compounds by liquid chromatography with ultraviolet detection. Alternatively, the thiols can be regenerated from DTNP derivatives using tributylphosphine and derivatized with 0-phthalaldehyde. The DTNP derivatives were stable at pH 5 and 6 for more than 2 weeks in the reaction mixture, but the stability was considerably lower at pH values > 8. Derivatization at pH 6 was routinely done and the reaction was complete within 5 minutes. The derivatives can be extracted quantitatively on commercial C18 cartridges, which allows several-fold sample enrichment. The cartridge-adsorbed derivatives are

stable at 0-5 C for long periods and, therefore, can be stored for liquid chromatography separation at a later date. DTNP derivatives of 10 low-molecular-weight thiols were separated on a C18 microbore column using gradient elution and a flow-rate of 200 microliters/minute. The relative standard deviation based on repeated analyses of standards is about 5% in the range 0.5-2 micromoles. Without C18 cartridge enrichment, the detection limits of the studied thiols are in the range 50-100 nanomoles. These limits are further reduced by about 100-fold by using the 0-phthalaldehyde method after regeneration of thiols from the DTNP derivatives using tributylphosphine. The method was applied to coastal sediment pore water and anoxic Black Sea water. Organic-rich sediment pore water samples from Biscayne Bay, FL, had 3-mercaptiopropionic acid present as the dominant thiol in almost all samples. Thiols detected in Black Sea water included glutathione and 2-mercaptoethanol. (Mertz-PTT)
W91-03459

CRITICAL COMPARISON OF TWO STANDARD DIGESTION PROCEDURES FOR THE DETERMINATION OF TOTAL MERCURY IN NATURAL WATER SAMPLES BY COLD VAPOUR ATOMIC ABSORPTION SPECTROMETRY.
Umea Univ. (Sweden). Dept. of Analytical Chemistry.
D. C. Baxter, and W. Frech.
Analytica Chimica Acta ACACAM, Vol. 236, No. 2, p 377-384, September 17, 1990. 2 fig, 5 tab, 26 ref.

Descriptors: *Analytical methods, *Atomic absorption spectrophotometry, *Chemical analysis, *Laboratory methods, *Mercury, *Pollutant identification, *Water analysis, Digestion, Ion exchange, Marshes, Standards, Swedish Standard method, West German Standard method.

Two pretreatment procedures for total mercury determinations in natural water samples were compared. The first, the Swedish Standard method, involves digestion of water in the presence of concentrated nitric acid at 120 C and under pressure for 30 minutes. In the West German Standard method, small volumes of nitric and sulfuric acids, permanganate and peroxodisulfate are added to the sample, and digestion proceeds at 50 C in an ultrasonic bath. Mercury was determined after both digestion procedures using a modified cold vapor atomic absorption spectrometric method, in which mercury generated after the addition of a reducing agent is collected and atomized in a platinum-lined graphite furnace. The efficacy of the two digestion procedures was tested using various standard organic mercury compounds, and it was found that only the West German Standard method provided quantitative recoveries. Purification of the reagents required by the West German Standard method was achieved using a mercury-selective ion-exchange resin, Chelite S, resulting in blank levels below 21.5 nanograms Hg/L. Both methods were applied to the determination of total mercury in an unpolluted marsh water sample, giving 2.0 nanogram Hg/L with the Swedish Standard method and 2.7 nanogram Hg/L with the West German Standard method. The West German Standard digestion procedure is recommended for the determination of total mercury in natural water samples. (Author's abstract)
W91-03460

PRECONCENTRATION OF LEAD, CADMIUM, COPPER AND ZINC IN WATER AT THE G/G LEVEL BY NON-BOILING EVAPORATION.
Laboratoire de Glaciologie et Geophysique de l'Environnement, Saint-Martin d'Heres (France).
U. Gorlach, and C. F. Boutron.
Analytica Chimica Acta ACACAM, Vol. 236, No. 2, p 391-398, September 17, 1990. 2 fig, 5 tab, 24 ref.

Descriptors: *Analytical techniques, *Cadmium, *Chemical analysis, *Copper, *Evaporation, *Lead, *Pollutant identification, *Snow, *Water analysis, *Zinc, Analytical methods, Antarctica, Atomic absorption spectrophotometry, Greenland, Heavy metals, Teflon.

Various improvements have been made for the preconcentration of Pb, Cd, Cu, and Zn to allow efficient control of contamination problems at these extremely low, non-boiling evaporation technique concentrations. They include the choice of FEP Teflon for the evaporation containers and the use of sophisticated cleaning, aging and pre-conditioning procedures. Detailed calibration graphs were obtained down to the sub-picagram/g level by processing ultra-low concentration standards. This technique was then applied to the determination of Pb, Cd, Cu, and Zn in snow samples collected in Greenland and Antarctica. Surface Greenland snow samples allowed a check of whether the different chemical forms could lead to different behaviors during the evaporation process. The concentrations of heavy metals were measured in three typical surface Greenland snow samples by direct graphite furnace atomic absorption spectrometry and by graphite furnace atomic absorption spectrometry after preconcentration. The results confirmed the reliability of the evaporation preconcentration procedure for real samples in which the chemical forms of the metals were more complex than in synthetic standards. In three typical Antarctic snow samples concentrations ranged from 2.5-9.5 picagrams/g for Pb, from < 0.2-0.7 picagram/g for Cd, from 2.3-4.7 picagram/g for Cu and from 2.4-8.3 picagram/g for Zn. The precision was found to range from about 25% for the lowest concentrations to less than about 10% for the highest concentrations. (Mertz-PTT)
W91-03461

DETERMINATION OF VANADIUM IN WATER BY ATOMIC ABSORPTION SPECTROMETRY WITH ELECTROTHERMAL ATOMIZATION AND USING HOT INJECTION AND PRECONCENTRATION ON THE GRAPHITE TUBE.
Santiago Univ. (Spain). Faculty of Chemistry.
P. Bermejo-Barrera, E. Beciero-Gonzalez, and A. Bermejo-Barrera.
Analytica Chimica Acta ACACAM, Vol. 236, No. 2, p 475-477, September 17, 1990. 1 tab, 16 ref.

Descriptors: *Analytical techniques, *Atomic absorption spectrophotometry, *Chemical analysis, *Pollutant identification, *Vanadium, *Water analysis, Analytical methods, Laboratory methods.

To determine vanadium in freshwater, the atomic absorption spectrometry with electrothermal atomization has been used, but owing to the low levels present, preconcentration is necessary. This is accomplished using hot injection and preconcentration on a graphite tube. The water sample (200 microliters) is added to a heated graphite tube in four portions over 200 seconds, with magnesium nitrate used as a matrix modifier. The relative standard deviation of ten replicate analyses of one sample during the same run was 5.43%. The within-batch precision of the method, obtained from ten replicate analyses of water samples with 1 microgram vanadium/L was 10.8%; 1 microgram/L was 7.4%; 3 microgram/L, 3.4%; and 5 microgram/L, 3.7%. To study the accuracy of the method, standard reference material water from the International Atomic Energy Agency, with a vanadium content of 5.8 microgram/L and a confidence interval of 4.9-10 microgram/L was used. The vanadium content in this reference material obtained using the proposed method was 6.23 +/- 0.86 microgram/L. The method allows vanadium down to 0.27 microgram/L to be detected. (Mertz-PTT)
W91-03462

DETERMINATION OF TRACE CONCENTRATIONS OF VOLATILE ORGANIC COMPOUNDS IN GROUND WATER USING CLOSED-LOOP STRIPPING, EDWARDS AQUIFER, TEXAS.
Geological Survey, Austin, TX.
P. M. Buszka, S. D. Zaugg, and M. G. Werner.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 4, p 507-515, October 1990. 1 fig, 2 tab, 17 ref.

Descriptors: *Edwards Aquifer, *Groundwater quality, *Path of pollutants, *Pollutant identification, *Water analysis, *Water pollution sources, Biodegradation, Chemical analysis, Groundwater chemistry, Groundwater pollution, Organic compounds, Tetrachloroethene, Texas, Toluene, Water quality, Xylenes.

The Edwards Aquifer in the Cretaceous Edwards Limestone in southcentral Texas is the sole source of drinking water for San Antonio, and is the major source of water for much of the region. Areas considered most susceptible to contamination from surface sources are the aquifer outcrop and the part of the aquifer downdip from the outcrop that is unconfined, collectively known as the recharge area. Volatile and semivolatile organic compounds were examined to see if they occurred at less than microgram/L concentrations, and to assess the potential use of such compounds for regional tracers of groundwater quality. Water samples were collected from four wells in the recharge area and at Comal Springs, a major discharge site from the confined zone. Closed-loop stripping was used to extract, and gas chromatography/mass spectrometry to separate, identify, and quantify organic compounds in water. Several compounds classified as priority pollutants by the U.S. EPA were detected in the water samples. Tetrachloroethene was detected in all samples collected from Comal Springs and from two recharge-area wells in areas with septic sewers. Methyl benzene (toluene) and a dimethyl benzene (xylene) isomer were inconsistently detected among replicate samples. This inconsistency, in combination with losses of surrogate compounds indicated biodegradation as a probable cause of the losses. Trichloroethene was detected in one sample from Comal Springs. The compound 2,6-bis-di-tert-butyl-p-butyl-p-benzoquinone, an indicator of pollution of water by sewage, was detected in well samples. Two of the compounds detected, tetrachloroethene and 2,6-bis-di-tert-butyl-p-benzoquinone, are potentially viable tracers of human-induced effects on groundwater quality. Results indicate a tentative relation between the presence of these compounds and patterns of domestic waste disposal. (Mertz-PTT)
W91-03465

ORDINATION ANALYSIS AND BIOINDICES BASED ON ZOOBENTHOS COMMUNITIES USED TO ASSESS POLLUTION OF A LAKE IN SOUTHERN FINLAND.
Ristola (Paavo) Consulting Engineers Ltd., Hollola (Finland).
P. H. Kansanen, L. Paasivirti, and T. Vayrynen.
Hydrobiologia HYDRB8, Vol. 202, No. 3, p 153-170, August 31, 1990. 6 fig, 6 tab, 33 ref, 2 append.

Descriptors: *Benthic fauna, *Bioindicators, *Eutrophic lakes, *Finland, *Limnology, *Multivariate analysis, *Pollutant identification, *Pollution index, *Water pollution effects, Benthic environment, Ecosystems, Midges, Oligochaetes, Oligotrophic lakes, Sampling, Species diversity, Statistical analysis, Water depth, Water pollution, Water quality, Wood wastes.

When the state of a polluted watercourse is evaluated on the basis of zoobenthic data, it is necessary to reduce the large number of measured parameters. The suitability of an ordination method, detrended correspondence analysis (DCA), was tested in assessing the degree of pollution of a large lake on the basis of the zoobenthos communities. Lake Etela-Saimaa, in southern Finland, was originally oligotrophic but is now heavily loaded by effluents from the wood-processing industry. Comparison between areas was complicated by variation in the water depths of the lake sub-basins. A horizontal pollution gradient could, however, easily be detected by means of the DCA in both the profundal and sublittoral zones. The benthic quality index (BQI) based on the composition of the profundal chironomid fauna failed at some stations because the indicator species were lacking, despite enlargement of the indicator species pool. The BQI based on the oligochaetes could be calculated at almost all the stations. This index was modified by altering the empirical constants for two species. Diversity indices and the occurrences of a single species had a limited value in the water

quality assessment. The study concluded that DCA ordination is a powerful tool in evaluation of pollution. The method gives the best results when the sampling network is carefully planned and the material represents all sections of the underlying environmental gradients, e.g. a gradient from oligotrophy to eutrophy or heavy pollution. (Author's abstract)
W91-03490

ULVA LACTUCA AS BIOINDICATOR OF METAL CONTAMINATION IN INTERTIDAL WATERS IN HONG KONG.
Hong Kong Univ. Dept. of Botany.
Y. B. Ho.
Hydrobiologia HYDRB8, Vol. 203, No. 1/2, p 73-81, September 14, 1990. 3 fig, 5 tab, 17 ref.

Descriptors: *Algae, *Bioindicators, *Heavy metals, *Hong Kong, *Intertidal areas, *Marine pollution, *Metals, *Pollutant identification, *Water pollution, *Water pollution effects, Cadmium, Chlorophyta, Copper, Industrial wastewater, Iron, Lead, Manganese, Nickel, Pollution index, Rural areas, Sea lettuce, Urban areas, Zinc.

The cosmopolitan green alga Ulva lactuca L. is widespread along the shores of Hong Kong. It grows well in intertidal waters, and accumulates high nutrient levels in urban areas contaminated by domestic sewage. The use of Ulva as an indicator of metal contamination was assessed by analyzing the levels of Mn, Fe, Ni, Cu, Zn, Cd, and Pb in the alga collected from 24 intertidal sites around the Island of Hong Kong. Twelve of the sites are in the rural southern parts of the Island where the coastal waters are relatively clean. The remaining 12 sites are located in the north and within Victoria Harbour which receives, apart from industrial effluents, untreated domestic sewage from a population of some 3.5 million. The mean levels of Mn, Fe, Ni, Cu, Zn, and Pb in Ulva from the urban sites were respectively 4.0, 4.6, 1.8, 2.3, 2.4, and 4.6 fold greater than those from the rural sites. However, similar levels of Cd were found in the alga among all the sites. Locations of high levels of metal contamination, particularly toward the eastern end of the Harbour, have been identified. Preliminary results indicate that Ulva is a good indicator of Mn, Fe, Cu, Zn, and Pb contamination. (Author's abstract)
W91-03498

METHODS DEVELOPMENT AND IMPLEMENTATION FOR THE NATIONAL PESTICIDE SURVEY.
Environmental Protection Agency, Cincinnati, OH.
D. J. Munch, R. L. Graves, R. A. Maxey, and T. M. Engel.
Environmental Science and Technology ESTHAG, Vol. 24, No. 10, p 1446-1451, October 1990. 1 fig, 7 tab, 1 ref.

Descriptors: *Data acquisition, *National Pesticide Survey, *Network design, *Pesticides, *Pollutant identification, *Surveys, Baseline studies, Domestic water, Drinking water, Environmental Protection Agency, Municipal water, Path of pollutants, Water sampling, Wells.

In 1984, a joint project between EPA's Office of Drinking Water and the Office of Pesticide Programs was initiated to conduct a statistically based survey of pesticide contamination of drinking water wells. The National Pesticide Survey had two objectives: to provide statistically valid data that can be extrapolated to represent both rural domestic and community drinking-water wells nationally and to evaluate possible associations between pesticide contamination of drinking water wells and pesticide use and hydrogeological vulnerability. Pesticides selected for study had to meet several criteria: use of at least 1,000,000 pounds in 1982, water solubility greater than 30 mg/L and hydrolysis half-life longer than 25 weeks. By October 1986, a total of 100 pesticides and their degradation products were identified as priority analytes. Steps for research into the analyses of these compounds included methods development research, methods consolidations, research into confirmation techniques, sample preservation studies and ruggedness testing and validation of final methods. A pilot study was conducted in March and April 1987. In April 1988, sampling began for the full survey. Sampling of community water systems was completed in December 1989, and of the domestic systems in February 1990. 600 community systems and 800 domestic wells were sampled. (Mertz-PTT)
W91-03507

HISTORICAL PERSPECTIVE ON THE ENVIRONMENTAL BIOAVAILABILITY OF DDT AND ITS DERIVATIVES TO GULF OF MEXICO OYSTERS.
Texas A and M Univ., College Station. Dept. of Oceanography.
For primary bibliographic entry see Field 5B.
W91-03509

ASSESSING TOXICITY OF DRINKING WATER CONTAMINANTS: AN OVERVIEW.
Vanderbilt Univ., Nashville, TN. Dept. of Biochemistry.
R. A. Neal.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 10, p 44-47, October 1990. 13 ref.

Descriptors: *Drinking water, *Risk assessment, *Toxicity, *Toxicology, *Water analysis, *Water treatment, Carcinogenicity, Chemical analysis, Contaminants, Epidemiology, Mathematical studies, Testing procedures, Water quality.

Chemical contaminants in drinking water can cause a variety of adverse health effects in humans, and a number of means are available to assess the toxicity of these chemicals. The most important means are epidemiology and animal tests. Epidemiology provides the most direct and least ambiguous information in that it assesses the actual occurrence of toxic effects in human populations exposed to chemical contaminants. Unfortunately, these are limitations to the use of epidemiology. Currently, experimental testing of animals is the most important means available to determine the toxicity of chemicals. A major limitation of these tests is the uncertainty about their applicability to humans. This uncertainty extends not only to differences in the qualitative responses of animals and humans to chemicals but more particularly to differences in the degree of response to various exposure levels. The usual practice for assessing a chemical's noncarcinogenic toxic effects in humans is to determine, based on epidemiology studies or rodent tests, the dose at which a toxic effect seen at higher doses is no longer observed, called the no-observed-effect level. In rodents exposed to a drinking water contaminant get cancer, or if cancer has been detected in an epidemiological study, then the current practice of the US EPA is to use a mathematical model to estimate the cancer incidence in humans that could result from the low levels of exposure associated with consuming contaminated drinking water. These mathematical models use the dose-response data in rodents and data from available epidemiological studies along with the estimated levels of human exposure to the chemical of interest. The major strength of mathematical modeling of human cancer risk ar that it is relatively easy to do and it provides an opportunity for regulatory agencies to base their decisions on an estimate of the degree of risk. The validity of the predictions of cancer risk in humans calculated using these mathematical models has, however, never been verified experimentally. (Mertz-PTT)
W91-03527

ASSESSMENT OF AQUATIC ORGANISMS AS BIOINDICATORS OF HISTORICAL RADIONUCLIDE RELEASE TO THE COLUMBIA RIVER.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5B.
W91-03564

TOXICITY BIOASSAYS: WATER POLLUTION EFFECTS ON AQUATIC ANIMALS AND PLANTS (JUN 86-FEB 90). CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE.
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 10C.
W91-03569

METHODS FOR THE DETERMINATION OF ORGANIC COMPOUNDS IN DRINKING WATER.
Environmental Monitoring Systems Lab., Cincinnati, OH.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-220461/AS. Price codes: A17 in paper copy, A01 in microfiche. Report No. EPA/600/4-88/039. December 1988. 392p, 35 fig, 63 tab, 96 ref.

Descriptors: *Chemical analysis, *Drinking water, *Laboratory methods, *Organic compounds, *Pollutant identification, *Water analysis, Disinfection, Extraction techniques, Gas chromatography, Liquid chromatography, Mass spectrometry.

Thirteen analytical methods for the identification and measurement of organic compounds in drinking water are described in detail. Six of the methods are for volatile organic compounds (VOCs) and certain disinfection by-products. These methods were cited in the Federal Register of July 8, 1987, under the National Primary Drinking Water Regulations. The other seven methods are designed for the determination of a variety of synthetic organic compounds and pesticides, and these methods were cited in proposed drinking water regulations in the Federal Register of May 22, 1989. Five of the methods utilize the inert gas purge-and-trap extraction procedure for VOCs, six methods employ a classical liquid-liquid extraction, one method uses a new liquid-solid extraction technique, and one method is for direct aqueous analysis. Of the 13 methods, 12 use either packed or capillary gas chromatography column separations followed by detection with mass spectrometry or a selective gas chromatography detector. One method is based on a high performance liquid chromatography separation. (Author's abstract)
W91-03580

EVALUATION OF TREND DETECTION TECHNIQUES FOR USE IN WATER QUALITY MONITORING PROGRAMS.
Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 7B.
W91-03584

NUTRIENTS FOR BACTERIAL GROWTH IN DRINKING WATER: BIOASSAY EVALUATION.
Academy of Natural Sciences of Philadelphia, Avondale, PA. Stroud Water Research Center.
For primary bibliographic entry see Field 5F.
W91-03590

HEALTH ASSESSMENT FOR ALSCO ANACONDA NATIONAL PRIORITIES LIST (NPL) SITE, GNADENHUTTEN, OHIO.
Agency for Toxic Substances and Disease Registry, Atlanta, GA.
For primary bibliographic entry see Field 5B.
W91-03593

SEDIMENT QUALITY VALUES REFINEMENT: VOLUME 1 - DATA APPENDICES, 1988 UPDATE AND EVALUATION OF PUGET SOUND AET.
PTI Environmental Services, Bellevue, WA.
R. Barrick, S. Becker, L. Brown, H. Beller, and R. Pastorok.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-200406. Price codes: A13 in paper copy, A01 in microfiche. Final Report No. EPA/910/9-88/246B, September 1988. 296p, 26 tab.

Descriptors: *Data collections, *Pollutant identification, *Puget Sound, *Sediment contamination, *Washington, *Water pollution effects, Apparent Effects Threshold, Benthic fauna, Bioassay, Microtox, Oysters.

This report contains a detailed evaluation of the Apparent Effects Threshold (AET) approach. The AET approach can be used to develop chemical specific sediment quality values. As part of this effort, AET values were generated for Puget Sound, Washington, and applied in a predictive manner to approximately 300 stations. The objective of this investigation was to test the reliability of AET, and potential sediment quality standards based on AET, in predicting adverse biological effects associated with sediment contamination. Of the 201 benthic infauna stations and 287 amphipod bioassay stations evaluated, approximately 75% were in accordance with AET predictions. Approximately 96% of the 50 stations at which oyster larvae and microtox bioassays were performed were in accordance with AET predictions. Based on AET for the four biological indicators, Puget Sound maps were produced showing the location of predicted impacts in the estuary. This effort involved the generation and evaluation of AET for 58 metal and organic chemicals. (Author's abstract)
W91-03599

MUSSELS (MYTILUS EDULIS L.) IN COASTAL WATER QUALITY CONTROL (DIE MIESMUSCHEL (MYTILUS EDULIS L.) ALS INDIKATOR VON UMWELTBELASTUNGEN).
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
H. Fischer.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-794682. Price codes: A04 in paper copy, A01 in microfiche. Report UBA-FB--86-069, May 1986. 54p, 9 fig, 5 tab, 84 ref. English summary.

Descriptors: *Bioindicators, *Cadmium, *Mussels, *Path of pollutants, *Pollutant identification, *Salinity, *Water pollution effects, Growth, Heavy metals, Lead, Shell weight, Tissue analysis, Zinc.

Low salinity was supposed to be a natural reason of higher Cd concentration in mussels from the Baltic Sea. Research on this topic evolved to a reformed 'mussel watch' concept. Shell weight as an independent variable in relation to Cd content of molluscs. Analysis of field samples: Reference of body burden to shell weight (Cd/shell-wt index) eliminates variability due to fluctuation of tissue-wt of Cd concentration. Influence of temperature, salinity, and oxygen on Cd balance of mussels. Experimental studies: Verification of Cd/shell-wt index as a reliable indicator. Low salinity produces high Cd levels in mussels. Essential in related research: growth. Cd, Zn, Pb, and Cu in mussels: (1) Field samples: Reference of Pb and Zn to shell-wt.; reference of Cu to soft-tissue wt.; and (2) Experiments: effects of metals on growth; metal levels in mussels. Bionindication of Zn is complicated by regulated uptake. Growth in the environment and reference of non-regulated, cumulative contaminants to shell weight are elements of a future 'mussel watch' routine. (Author's abstract)
W91-03605

PROCEEDINGS OF THE SIXTH CORPS CHEMISTS MEETING, 16-17 MAY 1989.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
Available from the National Technical Information Service, Springfield, VA 22161. Miscellaneous Paper EL-90-14, September 1990. Final Report. Compiled by A. B. Strong and A. B. Morrow. 33p.

Descriptors: *Chemical analysis, *Conferences, *Path of pollutants, *Pollutant identification, *Sediment analysis, *Water analysis, *Water chemistry, Groundwater pollution, Hydrocarbons, Organic compounds, Polychlorinated biphenyls, Soil analysis, Soil contamination, Underground storage tanks.

Presentations and discussions given are centered around analytical methods used by the Army Corps of Engineers, the expanding Corps mission in hazardous and toxic waste (HTW) work, the continuing importance of water quality programs, quality assurance for Corps projects, and communications between field and laboratory personnel. Topics presented include: polychlorinated biphenyl (PCB) congener toxicity; influence of groundwater well casings on organic and inorganic analytes; influence of soil sampling and soil history in investigating soil-mediated processes; sediment analysis case studies; petroleum hydrocarbon methods; and, chemistry work involved with underground storage tank removal. (Lantz-PTT)
W91-03659

SPECTROPHOTOMETRIC DETERMINATION OF ANIONIC SURFACTANTS IN TAP AND RIVER WATERS WITH 1-(10-BROMODECYL)-4-(4-AMINONAPHTHYLAZO)-PYRIMIDINIUM BROMIDE.
Okayama Univ. (Japan). School of Health Sciences.
Y. Shimoishi, and H. Miyata.
Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 338, No. 1, p 46-49, September 1990. 4 fig, 2 tab, 8 ref.

Descriptors: *Chemical analysis, *Pollutant identification, *Spectrophotometry, *Surfactants, *Water analysis, Laboratory methods, Sodium dodecylbenzenesulfonate, Sodium dodecylsulfate, Stoichiometry.

A new cationic dye, 1-(10-bromodecyl)-4-(4-aminonaphthylazo)-pyrimidinium bromide, was synthesized and evaluated as a new reagent for the determination of anionic surfactants. The reagent reacts with anionic surfactants, such as sodium dodecylsulfate and sodium dodecylbenzenesulfonate, to produce an ion associate in an aqueous medium. The color change occurs simultaneously, and the color development is very stable. This makes it possible to determine anionic surfactants directly by spectrophotometry without solvent extraction. The stoichiometric ratio of the ion associate was found to be 1:1 by the mole ratio method. The calibration graph was linear up to 2.5 micromoles/L. The apparent molar absorptivity of the ion associate was 53000 L/mole/cm (at 595 nm). The relative standard deviation (n = 10) for 1.2 micromoles/L sodium dodecylsulfate was 4.9%. The proposed method was applied to the determination of anionic surfactants in tap and river waters, with results comparable to those obtained by other methods. (Author's abstract)
W91-03839

GAS CHROMATOGRAPHIC DETERMINATION OF SYSTEMIC FUNGICIDE TRICYCLAZOLE IN SOIL AND WATER.
Zhejiang Agricultural Univ., Hangzhou (China). Dept. of Plant Protection.
Y. Xiao, D. Fan, and H. Chen.
Journal - Association of Official Analytical Chemists JANCA2, Vol. 73, No. 5, p 761-763, September/October 1990. 2 fig, 2 tab, 7 ref.

Descriptors: *Fungicides, *Laboratory methods, *Pollutant identification, *Soil analysis, *Tricyclazole, *Water analysis, Chemical analysis, Flame photometry, Gas chromatography, Organic compounds, Soil contamination.

Tricyclazole, 5-methyl-1,2,4-triazolo(3,4-b)benzothiazole, is a systemic fungicide for control of rice blast disease. Tricyclazole can be extracted from soil by refluxing with ethyl acetate-acetone (80 + 20 v/v) and from water by partitioning into dichloromethane. The soil extract is purified by coagulation. The compound is detected and measured by gas chromatography using a flame photometer operated in the sulfur mode. Detection limits are 8 ppb for soil and 0.8 ppb for water. Recoveries for control samples fortified with tricyclazole at 0.1-5.0 ppm averaged 97.1% for soil and 108.1% for water. (Author's abstract)
W91-03846

ALTERATIONS IN THE ENERGY METABOLISM OF AN ESTUARINE MYSID (MYSIDOPSIS BAHIA) AS INDICATORS OF STRESS FROM CHRONIC PESTICIDE EXPOSURE.
Environmental Research Lab., Gulf Breeze, FL.
For primary bibliographic entry see Field 5C.
W91-03883

CHARACTERIZATION AND ASSAY CONDITIONS FOR USE OF ACHE ACTIVITY FROM SEVERAL MARINE SPECIES IN POLLUTION MONITORING.
Institut Francais de Recherche pour l'Exploitation de la Mer, Nantes. Lab. Effets Biologiques des Nuisances.
G. Bocquene, F. Galgani, and P. Truquet.
Marine Environmental Research MERSDW, Vol. 30, No. 2, p 75-89, 1990. 6 fig, 4 tab, 24 ref.

Descriptors: *Acetylcholinesterase, *Bioassay, *Bioindicators, *Laboratory methods, *Marine environment, *Monitoring, *Pollutant identification, *Water pollution effects, *Water quality, Biochemistry, Path of pollutants.

The use of biochemical change as an indicator of pollution has many advantages over chemical analysis, which can be difficult to perform and interpret. Moreover, among biological effects of pollutants, biochemical changes occur more quickly than physiological response, thus providing earlier warning of a potential pollution effect. Acetylcholinesterase (AChE) activity was investigated in eight marine species of potential value for monitoring pesticides. AChE, butyrylcholinesterase (BUChE) and propionylcholinesterase (PChE) activities were compared, and optimal conditions of extraction, storage and measurement were determined. TRIS extract buffer 0.1 M, pH 8, was found to provide good specific production. AChE activity was not altered by freezer storage at -20 C. Optimal measurement temperatures ranged from 20 to 34 C, and pH was optimal between 6.5 and 8.5. Because marine sediments are recognized as a suitable environment for chemical contaminants, benthic or demersal species have been selected for monitoring investigations. Plaice (Pleuronectes platessa) and common prawn (Palaemon serratus) were found to have the highest AChE levels are thus recommended for monitoring the effects of anticholinesterase compounds. (Lantz-PTT)
W91-03885

HEAVY METAL ACCUMULATION BY BARNACLES AND ITS IMPLICATIONS FOR THEIR USE AS BIOLOGICAL MONITORS.
Victoria Univ. of Manchester (England). Dept. of Environmental Biology.
M. I. Powell, and K. N. White.
Marine Environmental Research MERSDW, Vol. 30, No. 2, p 91-118, 1990. 1 fig, 5 tab, 81 ref.

Descriptors: *Barnacles, *Bioaccumulation, *Bioindicators, *Heavy metals, *Monitoring, *Path of pollutants, Bioassay, Biological studies, Cadmium, Copper, Lead, Marine environment, Salinity, Water quality, Zinc.

As part of an investigation into the suitability of barnacles as biological monitors, the effect of metal exposure and a number of intrinsic and extrinsic factors on Cd, Cu, Pb and Zn levels in Semibalanus balanoides bodies was examined, with limited comparative studies on Balanus crenatus. No regulation was apparent over exposure periods of up to 100 days at added concentrations of 5-60, 20-90, 50-200 and 20-80 microgm/L of Cd, Cu, Zn and Pb. Accumulation rates of metals in bodies and egg masses were proportional to added metal concentrations although rates in egg masses increased with brood time. A single collection at 50 days post-exposure gave a similar indication of ambient metal levels and would be preferable for a routine monitoring program. Metal levels were negatively correlated with body weight, necessitating weight-normalization of data. Decreases in body metal levels following transfer to an uncontaminated environment were due to dilution by body weight increase rather than excretion. Cadmium accumulation was most influenced by salinity and some other metals (Cu increased uptake although Zn had no effect). These experiments suggest that barna-

cles may be suitable monitors of Cu, Zn and possibly Pb. Intermetallic effects argue against their use to assess Cd contamination. (Author's abstract)
W91-03886

DETERMINATION OF RADON IN WATER BY ARGON PURGING AND ALPHA COUNTING WITH A PROPORTIONAL COUNTER.
Ecole Polytechnique, Montreal (Quebec).
For primary bibliographic entry see Field 7B.
W91-03888

5B. Sources Of Pollution

TRAVELTIME AND REAERATION COEFFICIENTS FOR THE NORTH PLATTE RIVER, CASPER TO ORIN, WYOMING.
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 2E.
W91-02959

HYDROGEOLOGIC AND CHEMICAL DATA FOR THE O-FIELD AREA, ABERDEEN PROVING GROUND, MARYLAND.
Geological Survey, Towson, MD. Water Resources Div.
P. R. Nemoff, and D. A. Vroblesky.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-238, 1989. 70p, 18 fig, 24 tab, 3 ref.

Descriptors: *Aberdeen Proving Ground, *Aquifers, *Bottom sediments, *Groundwater, *Groundwater pollution, *Hydrologic data, *Landfills, *Maryland, *Organic compounds, *Organic solvents, *Surface water, *Water pollution sources, Chemical analysis, Confining beds, Contamination, Detection limits, Field tests, Herbicides, Hydrographs, Hydrology, Inorganic compounds, Lithologic logs, Migration, Radiation, Sampling, Volatility, Waste disposal, Water level.

O-Field, located at the Edgewood area of Aberdeen Proving Ground, Maryland, was periodically used for disposal of munitions, waste chemicals, and chemical-warfare agents from World War II through the 1950's. This report includes various physical, geologic, chemical, and hydrologic data obtained from well-core, groundwater, surface water, and bottom-sediment sampling sites at and near the O-Field disposal area. The data are presented in tables and hydrographs. Three site-location maps are also included. Well-core data include lithologic logs for 11 well-cluster sites, grain-size distributions, various chemical characteristics, and confining unit characteristics. Groundwater data include groundwater chemistry, method blanks for volatile organic carbon, available data on volatile and base/neutral organics, and compilation of corresponding method blanks, chemical-warfare agents, explosive-related products, radionuclides, herbicides, and groundwater levels. Surface-water data include field-measured characteristics; concentrations of various inorganic constituents including arsenic; selected organic constituents with method blanks; detection limits of organics; and a compilation of information on corresponding acids, volatiles, and semivolatiles. Bottom-sediment data include inorganic properties and constituents; organic chemistry; detection limits for organic chemicals; a compilation of information on acids, volatiles, and semivolatiles; and method blanks corresponding to acids, volatiles, and semivolatiles. A set of 15 water-level hydrographs for the period March 1986 through September 1987 also is included in the report. (USGS)
W91-02964

TIME OF TRAVEL OF SOLUTES IN THE TRINITY RIVER FROM DALLAS TO TRINIDAD, TEXAS, MAY AND AUGUST 1987.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 2E.
W91-02969

HYDROLOGY, AQUATIC MACROPHYTES, AND WATER QUALITY OF BLACK EARTH CREEK AND ITS TRIBUTARIES, DANE COUNTY, WISCONSIN, 1985-86.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 2H.
W91-02974

INTER-AGENCY RESEARCH AND TECHNICAL INTEGRATION.
For primary bibliographic entry see Field 5G.
W91-02987

FATE AND TRANSPORT OF AIRBORNE PESTICIDES: AN OVERVIEW OF ATMOSPHERIC MODELLING REQUIREMENTS.
Agricultural Research Service, Beltsville, MD. Environmental Chemistry Lab.
For primary bibliographic entry see Field 5G.
W91-02992

CONSIDERATIONS FOR DATA COLLECTION TO SUPPORT SIMULATION ANALYSES IN THE SATURATED ZONE.
For primary bibliographic entry see Field 7A.
W91-02994

PESTICIDES IN STREAMS OF THE UPPER MIDWESTERN UNITED STATES.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5G.
W91-03002

STATUS UPDATE--NATIONAL PESTICIDE SURVEY.
For primary bibliographic entry see Field 5G.
W91-03004

GEOLOGIC MAPPING FOR PROTECTION OF GROUNDWATER RESOURCES.
For primary bibliographic entry see Field 7C.
W91-03005

ACID DEPOSITION IN MARYLAND: SUMMARY OF RESULTS THROUGH 1988.
Maryland Dept. of Natural Resources, Annapolis. Chesapeake Bay Research and Monitoring Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-182729. Price codes: A08 in paper copy, A01 in microfiche. Report No. AD-89-1, January 1989. 150p, 28 fig, 23 tab, 163 ref, append.

Descriptors: *Acid rain, *Acid rain effects, *Maryland, *Path of pollutants, *Research, *Water pollution sources, Air pollution, Environmental effects, Legislation, National Acid Precipitation Assessment Program, Water pollution control.

The report builds on the information contained in the previous annual reports (PPRP, 1987; 1988) and provides a summary of the scientific principles upon which acid deposition research has been based. The findings of recent research conducted in Maryland are documented along with the results of other research projects which facilitate a better understanding of acid deposition issues in Maryland. Chapter II summarizes the findings reported in the 1987 Interim Assessment produced by the National Acid Precipitation Assessment Program (NAPAP). Chapter III discusses the emission of acid deposition precursors and the resulting transformation, transport and deposition of these materials. Chapter IV evaluates the potential effects of acid deposition on aquatic and terrestrial ecosystems, as well as on human health and physical materials. Chapter V presents recent information on control technologies and other means of reducing the emission of acid deposition precursors. Chapter VI presents a summary of recent federal legislative initiatives to control acid deposition. Chapter VII was drafted with direct contributions from the Acid Deposition Advisory Committee (ADAC), identifying areas of uncertainty that remain in the assessment of the potential impacts of acid deposition in Maryland. (Lantz-PTT)
W91-03025

RADIOLOGICAL SURVEY OF SAN DIEGO BAY.
Eastern Environmental Radiation Facility, Montgomery, AL.
M. O. Semler, and R. L. Blanchard.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-210645. Price codes: A03 in paper copy, A01 in microfiche. EPA Report EPA 520/5-88-019, June 1989. 20p, 4 fig, 4 tab, 3 ref, append.

Descriptors: *Naval operations, *Nuclear reactors, *Path of pollutants, *Radioactive wastes, *Radioactivity, *San Diego Bay, *Water pollution sources, California, Cesium radioisotopes, Cobalt radioisotopes, Ecological effects, Sediment contamination, Tritium.

The Office of Radiation Programs of the US EPA identifies and evaluates environmental public health impacts of both natural and man-made radiation sources. Results of a survey conducted by the Eastern Environmental Radiation Facility personnel to assess the levels of environmental radioactivity resulting from maintenance and operation of nuclear powered warships in Dan Diego Bay, California are presented. A radiological survey of three sites in San Diego Bay provided the basis for the following conclusions: (1) Small quantities of 60-Co (0.02-0.05 pCi/g) are present in the bottom sediments in some areas of the harbor at the Submarine Base. Most, if not at all, of the 60-Co contamination present probably originated prior to the earlier 1967 survey that reported 60-Co as much as 300 times larger than those observed in this study. The highest 60-Co concentration measured is now less than 1% of the normal background radioactivity in harbor sediment samples. (2) No tritium or gamma ray detectors, other than trace amounts of those occurring naturally, were detected in surface water from the dock areas or in nearby drinking water supplies. (3) Only radionuclides of natural origin and trace amounts of 137-Cs from fallout of previous nuclear weapons tests were detected in samples of kelp, algae, and fish taken from the harbor at the Submarine Base. (4) Gamma-ray surveys of the harbors near the docking areas and along shorelines and beaches near the shipyards failed to detect any exposure rates above background. (5) Based on this survey, operations related to nuclear-powered warship activities have contributed no increase in radioactivity to the harbors in San Diego Bay that would result in significant population exposure or contamination of the environment. Thus, under present conditions, Naval operations within San Diego Bay pose no radiological health problems to the public. (Lantz-PTT)
W91-03026

WATER-QUALITY VARIABILITY IN A CENTRAL FLORIDA WETLAND RECEIVING HIGHWAY RUNOFF.
Geological Survey, Altamonte Springs, FL.
D. M. Schiffer.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 7A-1--7A-11, 3 fig, 3 tab, 5 ref.

Descriptors: *Detention reservoirs, *Florida, *Highways, *Storm wastewater, *Urban runoff, *Water management, *Water pollution sources, *Water quality, *Wetlands treatment, Ammonia, Heavy metals, Lead, Orlando, Path of pollutants, Phosphorous, Sedimentation, Wetlands, Zinc.

Constituent concentrations were measured at the stormwater inlet and outlet, and at 9 other sites within a wetland receiving highway runoff, located north of Orlando, Florida. Most of the reduction in constituent concentrations in water observed in the wetland occurred within 100 feet of the stormwater inlet. Constituent concentrations measured in the wetland bed sediments indicate that the primary removal mechanism may be sedimentation. The 9 sampling sites within the wetland, in groups of three, were about 30, 100, and 250 ft from the stormwater inlet. Statistical analysis

of the data collected at the sampling sites indicate that for 26 of the 40 water quality variables, the mean values differ significantly (alpha equal to 0.05) with distance from the inlet. These differences were most frequently detected between the sites that are within 30 ft and 100 ft from the inlet. Constituents that generally decreased in concentration with distance from the inlet include total phosphorous, ammonia, lead and zinc. The median total phosphorous concentration at the inlet was 0.23 mg/l at 100 ft, and decreased to 0.04 mg/l at 100 ft. Total ammonia was 0.23 mg/l at the inlet, decreasing to 0.01 mg/l 100 ft away. Median concentrations decreased from 18 micrograms/l at the inlet to 4 micrograms/l at a distance of 100 ft, and median zinc concentrations decreased from 75 micrograms/l to 20 micrograms/l over the same distance. (Author's abstract)
W91-03058

PROCESSES AFFECTING RETENTION OF WATER-QUALITY CONSTITUENTS IN A DETENTION POND-WETLAND SYSTEM.
Geological Survey, Altamonte Springs, FL.
For primary bibliographic entry see Field 5D.
W91-03059

STATISTICAL-BASED METHODOLOGY FOR PRIORITIZING THE VULNERABILITY OF COMMUNITY GROUND-WATER SUPPLIES TO CONTAMINATION.
Illinois State Water Survey Div., Champaign.
K. J. Hlinka, and J. M. Shafer.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 8B-15--8B-23, 4 fig, 1 tab, 3 ref, append.

Descriptors: *Classification, *Geographic information systems, *Groundwater pollution, *Groundwater quality, *Groundwater resources, *Illinois, *Risk assessment, *Water resources management, Data interpretation, Maps, Public health, Water quality control.

Nearly 45% of all groundwater withdrawn in Illinois is used for public water supply. Therefore the susceptibility of community wells to contamination is a reasonable focus for public health concerns regarding groundwater quality. A methodology has been developed for prioritizing counties within Illinois according to the vulnerability of community groundwater supplies to contamination. A basic assumption is that the shallower the well, the more susceptible it is to contamination from surface activities. A geographic information system (GIS) was used to compute county composite vulnerability rankings and to develop computer generated maps showing statewide priority rankings. The GIS was also used to plot the distribution and depth of municipal wells included in the prioritization. Public water supply information from the Illinois EPA was provided by the Public-Industrial Commercial Survey database (PICS) of the Illinois State Water Survey (ISWS). Counties in central Illinois with a relatively large number of municipal wells finished in shallow sand and gravel deposits, were determined to have the greatest vulnerability. The results of this prioritization will be used by planning agencies to initiate groundwater protection efforts in counties with the highest ratings. (See also W91-03032) (Author's abstract)
W91-03071

GROUND WATER MODELING ANALYSIS FOR A CONTAMINATED WATER-SUPPLY WELL FIELD IN INDIANA.
Weston (Roy F.), Inc., West Chester, PA.
For primary bibliographic entry see Field 2F.
W91-03081

BIOTREATMENT: THE USE OF MICROORGANISMS IN THE TREATMENT OF HAZARDOUS MATERIALS AND HAZARDOUS WASTES.
For primary bibliographic entry see Field 5D.
W91-03097

METABOLIC DIVERSITY OF MICROBIAL BTEX DEGRADATION UNDER AEROBIC OR ANOXIC CONDITIONS.
Michigan Univ., Ann Arbor. Medical Center.
For primary bibliographic entry see Field 5D.
W91-03099

SEDIMENT AND NUTRIENT LOSSES FROM SUBSURFACE DRAINAGE.
Florida Univ., Gainesville. Dept. of Agronomy.
A. Bottcher, E. J. Monke, D. B. Beasley, and L. F. Huggins.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 622-633, 7 fig, 2 tab, 5 ref.

Descriptors: *Agricultural runoff, *Nonpoint pollution sources, *Nutrient loss, *Sediment yield, *Subsurface drainage, *Water pollution sources, Beans, Corn, Fertilizers, Indiana, Monitoring, Nitrogen losses, Performance evaluation, Seasonal distribution, Tillage, Water quality control, Wheat.

Erosion control practices often increase subsurface drainage and related nutrient losses. Since subsurface drainage is becoming more and more common, its water quality impacts need to be understood. A study was conducted with two objectives: to determine the water quality impact of the subsurface drainage system and to relate field management practices to the system's potential to pollute downstream waters. The monitored subsurface tile field (17.4 ha) is 2 mi south of Woodburn, Indiana; it has less than 1% slope and has raised field borders formed by ditching around the field. Ninety-five percent of the field is a Hoytville silty clay. The drainage system outlet was monitored for flow and water quality parameters using automatic sampling and recording equipment from April 1976 to June 1981. Different crops (corn, beans, wheat) were grown during the monitoring period and moldboard plowdown and disking were used. Fertilization was urea, ammonia, or ammonium nitrate. When surface runoff is restricted, subsurface drainage systems can control erosion and losses of sediment-associated nutrients and P in drainage water. However, N losses are only moderately reduced by such a system. Most of the subsurface drainage from the 17-ha field occurred as the result of winter moisture accumulation. Profile storage and increased evapotranspiration reduce summer subsurface drainage flow to nearly zero. More than 70% of the N lost in the drainage water was in the nitrate form. Approx 70% of the P lost was in the form of sediment-bound P. Sediment, sediment-bound P, and pesticides moved through the soil profile, indicating the presence of direct flow channels during periods of a storm. Tillage can moderately increase the leaching of sediment, sediment-associated nutrients, and soluble nutrients for a short period afterward. Heavy rain shortly after fertilization can increases of N and to a lesser degree P through the subsurface drainage system. (See also W91-03117) (Rochester-PTT)
W91-03168

NUMERICAL GROUNDWATER QUALITY MODELLING: THEORETICAL BASIS AND PRACTICAL APPLICATIONS.
Gesamthochschule Kassel (Germany, F.R.).
For primary bibliographic entry see Field 2F.
W91-03192

GROUNDWATER CONTAMINATION: PROCESSES, CHARACTERIZATION, ANALYSIS, AND REMEDIATION.
GeoTrans, Inc., Herndon, VA.
For primary bibliographic entry see Field 5G.
W91-03194

COUPLED MODELLING OF WATER CYCLE AND NITRATE TRANSPORT IN A HYDROLOGICAL SYSTEM.
Q. Z. Geng, G. Girard, and E. Ledoux.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 283-297, 6 fig, 2 tab, 4 ref.

Descriptors: *Groundwater pollution, *Hydrologic models, *Model studies, *Nitrates, *Nonpoint pollution sources, *Path of pollutants, Farm wastes, Flow models, France, Groundwater management, Groundwater movement, Surface-groundwater relations, Water resources development, Water resources management.

On a global scale, the main input of nitrogen in the ground comes from natural fixation of the nitrogen contained in the air; however, the major nitrogen pollution in water is caused by intensive agricultural activities. The nitrogen cycle which is responsible for the transfer of pollutant from the soil to the aquifers is governed by multiple and complex phenomena which must be simplified before attempting its modeling. A conceptual model of nitrate-leaching into the soil, taking into account nitrogen input and agricultural techniques. This model is compatible with a previously-developed spatially-discretized model of both surface and groundwater flow. This model has been validated to a lysimetrical case scale as well as to the scale of a small cultivated watershed in France. A foreseen utilization of such a model is the study of the influence of agricultural applications on the long-range evolution of groundwater quality. (See also W91-03178) (Fish-PTT)
W91-03195

ADIRONDACK WATERSHED DATA BASE: ATTRIBUTE AND MAPPING INFORMATION FOR REGIONAL ACIDIC DEPOSITION STUDIES.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 7C.
W91-03234

EFFECTS OF MISSING DATA ON THE CALCULATION OF PRECIPITATION-WEIGHTED-MEAN CONCENTRATIONS IN WET DEPOSITION.
Atmospheric Environment Service, Downsview (Ontario).
A. Sirois.
Atmospheric Environment Part A: General Topics AEATEN, Vol. 24, No. 9, p 2277-2288, September 1990. 9 fig, 2 tab, 8 ref.

Descriptors: *Acid rain, *Data quality control, *Meteorological data, *Precipitation, *Statistical analysis, *Water pollution sources, Algorithms, Nitrates, Simulation analysis, Sulfates, Uncertainty.

Uncertainties in the calculation of monthly, seasonal and annual precipitation-weighted-mean concentrations due to missing data are addressed. An algorithm is presented to estimate the effects of missing samples through the use of a simulation technique. Quantitative estimates of uncertainty due to missing data are given for monthly, seasonal and annual precipitation-weighted-mean sulfate and nitrate concentrations at six monitoring sites where daily precipitation samples were taken. It is found that the expected value of the precipitation-weighted-mean concentration estimator is biased if the percentage of missing samples (%MN), and the percentage (%MP) of the precipitation amount associated with the missing samples, are different. The absolute value of the bias becomes larger as the difference increases. The standard deviation of the estimator increases with increasing values of %MP. For a given value of %MP, it is a minimum when %MN is equal to %MP, and increases with increasing differences between %MN and %MP. These results indicate that %MN of about 10%, which is not uncommon in precipitation networks data, gives an uncertainty of about 10, 5, and 2% for monthly, seasonal and annual averaging periods, respectively. Of the types of application given, the calculation of confidence intervals for two or more precipitation-weighted-mean concentrations should be the most useful for day-to-day applications. (Author's abstract)
W91-03293

LABORATORY STUDY ON THE SCAVENGING OF SO2 BY SNOW CRYSTALS.
Mainz Univ. (Germany, F.R.). Meteorological Inst.
S. K. Mitra, S. Barth, and H. R. Pruppacher.
Atmospheric Environment Part A: General Topics AEATEN, Vol. 24, No. 9, p 2307-2312, September 1990. 5 fig, 1 tab, 26 ref. Ministry for Research and Technology of the F.R.G Project 325-4007-070458 and German National Science Foundation Project SFB-233.

Descriptors: *Acid rain, *Path of pollutants, *Precipitation scavenging, *Snow, *Sulfur dioxide, Chemistry of precipitation, Cloud chemistry, Crystal growth, Hydrogen peroxide, Ice.

The uptake of sulfur dioxide (SO2) by dendritic snow crystals was studied in two laboratory experimental series. In the first series, the uptake of SO2 was studied during the growth of the snow crystals from water vapor with and without the presence of hydrogen peroxide (H2O2) in the air. In the second series, the uptake of SO2 by snow crystals which had completed their growth was examined. Results showed that under both conditions SO2 became scavenged by snow crystals. The uptake of SO2 was particularly pronounced during the growth of the snow crystals, and at temperatures close to 0 C where a quasi-liquid layer exists at the surface of ice. The SO2 uptake became enhanced in the presence of H2O2. The present results are in qualitative agreement with previous studies involving bulk ice. (Author's abstract)
W91-03296

INTERACTION BETWEEN EQUILIBRATION PROCESSES AND WET OR DRY DEPOSITION.
California Inst. of Tech., Pasadena. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 2B.
W91-03297

NUMERICAL SIMULATION OF WET SCAVENGING OF AIR POLLUTANTS: I. MODELING OF SEQUENTIAL PRECIPITATION RATES AT THE GROUND.
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Chemical Engineering.
W. T. Tsai, and E. R. Altwicker.
Atmospheric Environment Part A: General Topics AEATEN, Vol. 24, No. 9, p 2473-2483, September 1990. 11 fig, 1 tab, 25 ref.

Descriptors: *Acid rain, *Air pollution, *Mathematical models, *Path of pollutants, *Precipitation rate, *Precipitation scavenging, Chemistry of precipitation, Cloud physics, Convective precipitation, Numerical analysis, Simulation analysis, Wind velocity.

A one-dimensional Eulerian transport/transformation/removal model is developed to explain and predict existing field data and chemical compositions of precipitation. The PLUVIUS model is used as the framework for the proposed model with significant modifications which take into consideration cloud dynamics, microphysics, and water phase. The equation of motion is solved to generate a vertical wind velocity profile for convective precipitation. The upwind scheme is used to handle the convective, non-linear transport problem. The modeling results of ground precipitation rates for a summer convective shower indicate that the precipitation rate is sensitive to the following precipitation parameters: autoconversion rate, cloud water concentration, relative humidity, entrainment rate, and the heights of cloud base and cloud type. (See also W91-03299) (Author's abstract)
W91-03298

NUMERICAL SIMULATION OF WET SCAVENGING OF AIR POLLUTANTS: II. MODELING OF RAIN COMPOSITION AT THE GROUND.
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Chemical Engineering.
W. T. Tsai, and E. R. Altwicker.
Atmospheric Environment Part A: General Topics AEATEN, Vol. 24, No. 9, p 2485-2498, September 1990. 9 fig, 4 tab, 38 ref.

Descriptors: *Acid rain, *Air pollution, *Chemistry of precipitation, *Mathematical models, *Path of pollutants, *Precipitation scavenging, Ammonia, Convective precipitation, Hydrogen peroxide, Nitrates, Numerical analysis, Ozone, Sulfates, Sulfur.

The modeling of rain composition for a convective shower (Tucson, Arizona, 10 September 1977) and a frontal precipitation event (Den Helder, Holland, 12 December 1978) is performed by including the pollutant species and wet scavenging mechanisms into the mass transport equation of a sequential sampling model. The major scavenging mechanisms for most pollutants in convective showers appear to be similar to those in frontal precipitation. The major scavenging mechanisms for ammonium and nitrate are gas absorption, whereas the absorption of sulfur dioxide by aqueous drops and oxidation of S(IV) by hydrogen peroxide and ozone in the aqueous phase are the major formation and scavenging mechanisms for sulfate. The scavenging by raindrops in the below-cloud region is the dominant removal mechanism for coarse particles, whereas nucleation is the major scavenging mechanism for submicrometer particles. Hydrogen peroxide is the most important oxidant responsible for the oxidation of S(IV) and the formation of sulfate in precipitation. The contributions of both sulfur dioxide plus hydrogen peroxide and sulfur dioxide plus ozone reactions to sulfate concentration in precipitation are larger for convective precipitation than for frontal precipitation. (See also W91-03298) (Author's abstract)
W91-03299

METALS IN ULVA LACTUCA IN HONG KONG INTERTIDAL WATERS.
Hong Kong Univ. Dept. of Botany.
Y. B. Ho.
Bulletin of Marine Science BMRSAW, Vol. 47, No. 1, p 79-85, July 1990. 3 fig, 3 tab, 11 ref.

Descriptors: *Algae, *Bioaccumulation, *Bioindicators, *Heavy metals, *Hong Kong, *Intertidal areas, Cadmium, Copper, Iron, Lead, Manganese, Nickel, Zinc.

The levels of Mn, Fe, Ni, Cu, Zn, Cd, and Pb in Ulva lactuca collected from 24 intertidal sites around the Island of Hong Kong were determined by flame atomic absorption spectrophotometry. Twelve of the sites are in the rural southern parts of the island where the coastal waters are relatively clean. The remaining 12 sites are located in the north and within Victoria Harbor which receives, apart from industrial effluents, untreated domestic sewage from a population of some 3.5 million. The mean levels of Mn, Fe, Ni, Cu, Zn and Pb in Ulva from the urban sites were respectively 4.0, 4.6, 1.8, 2.3, 2.4, and 4.6 times those from the rural sites. However, somewhat similar levels of Cd were found in the alga amongst all the sites. Some locations of high levels of metal contamination have been identified in Victoria Harbor. Preliminary findings indicated that Ulva is a good indicator of Mn, Fe, Cu, Zn and Pb contamination due to its cosmopolitan distribution, simple morphology leading to ease of growth assessment, and its graded tolerance and response to pollutants. (Author's abstract)
W91-03301

IMPACT OF INTENSIVE IRRIGATION ON GROUNDWATER REGIMEN IN PARTS OF OSMANSAGAR AREA, R. R. DISTRICT, A. P., INDIA.
Osmania Univ., Hyderabad (India). Dept. of Geology.
For primary bibliographic entry see Field 5G.
W91-03334

GROUNDWATER QUALITY OF AN ALLUVIAL AQUIFER.
Centre for Water Resources, Madras (India).
L. Elango, S. Manickam, M. V. Somasundaram, and J. H. Tellam.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 715-732, 8 fig, 1 tab, 11 ref.

Descriptors: *Alluvial aquifers, *Groundwater quality, *India, *Irrigation effects, *Nonpoint pollution sources, *Path of pollutants, *Water pollution sources, Confined aquifers, Evaporation, Groundwater management, Hydrologic budget, Mathematical models, Saline water, Seasonal variation, Water demand, Water supply.

A preliminary study was conducted of long-term water quality in the heavily exploited Arani-Korttalai alluvial aquifer in southern India. The aquifer consists of a low-permeability unconfined part that acts as a semi-confining layer to the lower high-permeability portion. The system is heavily pumped for water supply and local irrigation. Flow modeling suggests that much of the pumped water in deep wells is supplied by vertical leakage from the upper layer. Water quality is very variable spatially and appears to reflect the importance of vertical flow; some correlation with land use is observed. Water quality varies seasonally, with some wells showing and increase in salinity as water levels rise in response to the monsoon. This appears to be due to flushing of evaporation-concentrated salt in the unsaturated zone. Long-term data suggest that the system is generally stable chemically, possibly because of the volume of rainfall recharge. In some locations, however, water quality is changing. Preliminary salt balance calculations suggest that the system could be sensitive to changes in chemical inputs (especially fertilizers) under certain circumstances. (See also W91-03311) (Author's abstract)
W91-03335

ANALYSIS OF BREAKTHROUGH CURVES FOR ASSESSING MOVEMENT OF CONTAMINANTS.
Central Soil Salinity Research Inst., Karnal (India).
S. K. Gupta.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 769-777, 4 fig, 3 tab, 13 ref.

Descriptors: *Groundwater movement, *Groundwater pollution, *Mathematical models, *Model studies, *Path of pollutants, *Solute transport, Breakthrough curves, Groundwater quality, Mathematical equations, Monitoring, Porous media.

Transport of chemicals in porous media has received much attention as well-documented studies on pollution of groundwater resources from agricultural non-point sources have appeared. Movement of chemical in groundwater pollution problems has been studied mostly with breakthrough curves. A refinement to this approach has been developed based on the analysis of breakthrough curves for linearly absorbing ions. The theory has been developed to present dimensionless leached fractions and parameter identification equations. Whereas the solute concentration curves for adsorbing and non-adsorbing solutes merge at some pore volume, the leached fraction curves remain separate at all pore volumes. This is because part of the solute is adsorbed on the solid matrix. At higher pore volumes, the solutes in the solution phase, for both the interacting and non-interacting ions, are similar in concentration. At higher pore volumes the leached fraction becomes independent of the Peclet number and is a function of pore volume and the adsorption parameter (k) only. This fact provides the basis for deriving parameter identification equations. An equation is derived that is a variation of the solution of the dispersion convection model used as the basis for groundwater quality models. In the new form, the equation permits the direct evaluation of the threats to groundwater by giving the fraction of the total

solute that will contribute to groundwater loading. The method work wells when an comprehensive data base is lacking, allows the estimation of more than one pore volume parameter simultaneously without the need for additional tests for estimation of the adsorption coefficient, and eliminates the need for a breakthrough curve in field studies for parameter identification. The proposed changes do not force a major change in the existing framework of field management models applied to groundwater quality and monitoring programs. (See also W91-03311) (Rochester-PTT)
W91-03340

DISPERSION OF POLLUTANTS IN POROUS MEDIA FLOW ONE-DIMENSIONAL APPROACH.
College of Engineering, Poona (India).
D. G. Paygude, B. Vasudeva Rao, and S. G. Joshi.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 779-790, 7 fig, 12 ref.

Descriptors: *Computer models, *Finite element method, *Groundwater movement, *Groundwater pollution, *Mathematical equations, *Model studies, *Path of pollutants, *Solute transport, Cost analysis, Courant number, Peclet number, Porous media, Sparse matrix.

A numerical solution was developed for the one-dimensional form of the convective-dispersion equation for the case of saturated homogeneous isotropic flow in porous media using Galerkin's finite element formulation. The results obtained with the numerical solution were compared with those of the available analytical solution and the stability of the numerical result was studied in terms of the Courant number and Peclet number. The finite element method (FEM) results were in close agreement with those of the analytical solution. One-dimensional FEM results were stable for wider ranges of Courant number and Peclet number than had been previously stated. There was about a 70-80% saving in memory core of the computer when a compact storage scheme to store the Sparse matrix was employed. There was a considerable saving in central processing unit time when an element matrix was formed by using direct integration instead of numerical integration. (See also W91-03311) (Rochester-PTT)
W91-03341

NUMERICAL MODELLING OF MASS TRANSPORT EQUATION.
Banaras Hindu Univ., Varanasi (India). Dept. of Geophysics.
M. Banerjee.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 791-802, 2 fig, 14 ref.

Descriptors: *Groundwater movement, *Mathematical models, *Model studies, *Numerical analysis, *Path of pollutants, *Saline water intrusion, *Solute transport, Convection, Diffusion, Dispersion, Finite difference methods, Groundwater pollution, Hydrodynamics, Hysteresis, Infiltration, Soil water.

The general vertical mass transport equation for a porous medium involves convection, molecular diffusion, and hydrodynamic dispersion. This is a cumbersome hydrodynamic problem that must be solved only by a numerical technique. A numerical finite difference model was developed for solving the convective-diffusive-dispersion equation for mass transport through a rigid isotropic and homogeneous medium. Computer experiments were conducted for salt disposition within a profile of porous material. The results for mass concentration within a profile during infiltration and distribution processes are presented here for a soil column 3.5 m in length. They exhibit a lag in salinity front and salt peak. The dispersion effect was more pronounced during a redistribution event, thus indicating the importance of a numerical model, which accounts for hysteresis. Studies of salt movement under intermittent conditions indicate that most of the salt is being transported by convection, but dispersion is more significant during each cycle of intermittency. The shape of the concentration profiles is altered due to increasing dispersion. Models such as the present one may provide guidelines for setting the control between the surface supply of salt with water and the changes in the quality of soil water and groundwater during irrigation. (See also W91-03311) (Rochester-PTT)
W91-03342

SINGLE-PHASE/TWO-PHASES NUMERICAL MODEL USING NESTED SQUARE MESHES.
Ecole Nationale Superieure des Mines de Paris, Fontainebleau (France). Centre d'Information Geologique.
For primary bibliographic entry see Field 2F.
W91-03343

SEMI-ANALYTIC SOLUTION OF ONE-DIMENSIONAL DISPERSION CONVECTION EQUATION.
Punjab Agricultural Univ., Ludhiana (India). Dept. of Soil and Water Engineering.
S. Ram Singh, A. Kumar Saini, and S. K. Kamra.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 867-878, 2 fig, 13 ref.

Descriptors: *Convection, *Dispersion, *Groundwater movement, *Model studies, *Path of pollutants, *Solute transport, Differential equations, Finite element method, Mathematical equations, Mathematical models, Peclet number, Performance evaluation, Porous media, Semi-analytic solutions, Soil water.

The dispersion convection equation adequately describes the transport of a solute in porous media. The spatial discretization of the one-dimensional equation by Galerkin's finite element method yields a system of time-dependent, inhomogeneous ordinary differential equations. The solution of such an inhomogeneous matrix-vector differential equation is obtained with the help of the matrix exponential in exactly the same way as would be used with a scalar equation. The eigenvalue-eigenvector method of Euler is employed for computing the matrix exponential. The resulting solution is continuous in time. Results from this new model were compared with an analytic solution of the dispersion equation for describing the distribution of solutes flowing into a soil column of finite length. At low Peclet numbers the deviation in the semi-analytic solution compared to the analytic one is negligible. The error decreases with increased time at all Peclet numbers. At low Peclet numbers the trend is uniformly decreasing, whereas at high Peclet numbers it decreases with oscillation. (See also W91-03311) (Rochester-PTT)
W91-03348

NITRATE POLLUTION OF GROUNDWATER IN LUCKNOW AREA, U. P.
Central Ground Water Board, Lucknow (India).
V. K. Sahgal, R. K. Sahgal, and Y. P. Kakar.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 879-891, 2 fig, 4 tab, 12 ref.

Descriptors: *Groundwater pollution, *India, *Nitrates, *Path of pollutants, *Water pollution control, *Water pollution sources, Animal wastes, Fertilizers, Land disposal, Leaching, Lucknow, Public health, Septic tanks, Wastewater pollution.

With the establishment of a direct relationship between nitrate concentrations in drinking water and the incidence of methemoglobinemia, which can be fatal to infants, the study of nitrate in water supplies has assumed great importance. Studies were undertaken in the Lucknow area, India, demonstrating that nitrate levels several times higher than the prescribed limit of 45 mg/L were present. Nitrate concentrations in groundwater exceed 100 mg/L at several places and concentrations as high as 650 mg/L have been observed in shallow groundwater. Pollutants have adversely affected the groundwater quality in the depth range 100-135 m, with nitrate concentrations of 145, 168, and 590 mg/L in some of the tubewells. Preliminary investigations have identified the sources of nitrate pollution as leachates from soak pits, septic tanks, unlined sewage drains, and abandoned wells used for dumping wastes. Regular surveillance of nitrate is necessary. Measures that would help control this type of groundwater pollution include: (1) lining of drains carrying sewage to the river; (2) grouting of septic tanks found to be leaky; (3) treatment of raw sewage before it is discharged on land; (4) closing of abandoned wells to prevent their use for dumping of wastes; (5) use of fertilizers at optimal levels to prevent leaching to the groundwater; and (6) better management of wastes from dairy animals to prevent leaching to the groundwater. (See also W91-03311) (Rochester-PTT)
W91-03349

STUDY OF GROUNDWATER POLLUTION AT TIRUMALA, TIRUPATI, INDIA.
National Geophysical Research Inst., Hyderabad (India).
B. S. Sukhija, D. V. Reddy, and V. K. Saxena.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 893-897, 4 fig, 1 ref.

Descriptors: *Groundwater pollution, *India, *Water pollution sources, Groundwater chemistry, Nitrates, Path of pollutants, Sewers, Urban areas, Water chemistry, Water level.

The Tirumala temple at Tirupati, India, is one of the biggest pilgrim centers in India. North of the temple is a large water reservoir called Pushkarni in which thousands of devotees bathe before entering the temple. Dense residential complexes surround the temple. The sewers are both lined and unlined, and run along the four streets of the temple. An investigation was undertaken to determine the nature and extent of groundwater pollution in the area of the temple and to identify possible sources of pollution. Special emphasis was placed on four wells (Bangaur Bavi, Viraja Nadi, Pottu Bavi, and Poola Bavi). Including these four important wells, around 60 wells were monitored for water levels and water chemistry. Water level data collected so far indicate the presence of groundwater mounds around the temple area, with the movement of the Pushkarni water toward the well in the temple area. Groundwater chemistry indicates excess nitrates and suspended solids in most of the wells. The nitrate contents of the Pushkarni are close to those of two nearby wells supporting the influent condition of the Pushkarni. High contents of suspended solids, fat, and food material were detected in one of the wells. A simple tracer experiment established that a large kitchen was an important source of pollution. (See also W91-03311) (Rochester-PTT)
W91-03350

DISTRIBUTION OF FLUORIDE IN SHALLOW AQUIFERS IN AND AROUND DISTRICT ROHTAK, HARYANA STATE.
Panjab Univ., Chandigarh (India). Dept. of Geology.
For primary bibliographic entry see Field 2K.
W91-03354

NITRATE POLLUTION IN THE GROUNDWATER OF SANGAREDDY AREA, ANDHRA PRADESH, INDIA.
Osmania Univ., Hyderabad (India). Dept. of Geology.
G. Shankar Naryana, V. Sudarshan, and C. Narsimulu.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 917-920, 1 fig, 4 ref.

Descriptors: *Groundwater pollution, *India, *Nitrates, *Water pollution sources, Drinking water, Manjira River, Sangareddy area, Surveys, Wells.

The hydrogeochemical investigations of the groundwater from parts of the Manjira River basin (India) revealed two main zones of nitrate facies. Forty-two representative samples were obtained from dug wells, dug-cum-borewells, borewells, and filter points and analyzed with an Orion EATM expandable ion analyzer. The nitrate concentrations in the northern region of the river are below 45 ppm, which is the safe limit prescribed by the World Health Organization for potability of water. On the southern region of the river near Sangareddy township concentrations varied from 45 to 165 ppm. Although nitrogen fertilizers are often the cause of excessive nitrates in groundwater, no N fertilizer use or related industries exist in the study area. It is concluded that some other, unknown, anthropogenic cause accounts for the observed high nitrate levels. (See also W91-03311) (Rochester-PTT)
W91-03355

RADON, RADIUM AND URANIUM IN DRINKING WATER.
For primary bibliographic entry see Field 5F.
W91-03366

RADON TRANSFERRED FROM DRINKING WATER INTO HOUSE AIR.
Maine Univ. at Orono. Dept. of Physics and Astronomy.
C. T. Hess, M. A. Vietti, E. B. Lachapelle, and J. F. Guillemette.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 51-67. 5 fig, 6 tab, 20 ref. U.S. EPA Cooperative Agreement CR813554-01-2.

Descriptors: *Air pollution, *Drinking water, *Path of pollutants, *Radioisotopes, *Radon, Analytical methods, Maine, Pollutant identification, Population exposure, Water use.

A study was conducted to locate homes with high values of Rn-222 in the state of Maine. Forty Maine houses were selected with alleged Rn-222 in water concentrations higher than 5000 pCi/L. Rn-222 measurements were performed during two periods in each residence from Oct. 1986 to June 1987. During one period of approximately two hours duration, measurements were made while a series of simulated water use activities were conducted. Radon monitoring was performed over a second period of 24 hours, during which the residents used water according to their normal daily routine. Radon in water ranged up to 193,000 pCi/L. Water bursts ranged from 160-928 L. House volumes ranged from 190,000 to 2.2 million L. Air exchange was measured by both SF6 tracer diffusion and Rn-222 loss. The decay constant for SF6 ranged from 0.188 to 1.65 per hour, and the decay constant for Rn-222 ranged from 0.142 to 1.33 per hour. Emissivity ranged from 0.00 to 5.10, and Rn-222 transfer coefficients ranged from 0.00116 to 0.0000000301. The average value of the 24-hour transfer coefficient is 0.0000267 and is lower than the previous average of 0.00010. (See also W91-03366) (Agostine-PTT)
W91-03371

RELATIONSHIP OF RADIUM AND RADON WITH GEOLOGICAL FORMATIONS.
Research Planning Inst., Inc., Columbia, SC.
J. Michel.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 83-95. 3 fig, 2 tab, 19 ref.

Descriptors: *Geochemistry, *Geologic formations, *Radioisotopes, *Radium, *Radon, *Water pollution sources, Aquifers, Groundwater transport, Lithology, Radioactive half-life, Reviews, Water quality management, Wells.

A review is given of the available information for the isotopes Ra-228, Ra-226 and Rn-222 in groundwater, with emphasis on aquifers used as public water supplies. Ra-226 and Ra-228 are very different in several important ways. First, they are from different decay series. Ra-226 is the fifth member of the uranium-238 series and decays by alpha emission. Because U forms soluble complexes under oxidizing conditions it can be transported by groundwater over long distances. Ra-228 is the second member of the thorium-232 series and decays by beta emission. Th is extremely insoluble and is not subject to mobilization by groundwater. A second difference affecting the groundwater distribution of the Ra isotopes is their half-lives, 5.7 years for Ra-228 versus 1622 years for Ra-226. The Environmental Protection Agency sponsored two studies to determine the feasibility of using aquifer type and water-quality characteristics to predict the occurrence of Ra-228 in groundwater. An aquifer classification scheme was developed and the results were used to generate a map of the U.S. showing the distribution of areas with high, medium, and low probability of having elevated Ra-228. A similar, although more detailed, map was generated for Ra-226. Much more data were available for Ra-226 due to monitoring requirements and the fact that it is easier to measure. Radon is a gas with no chemical affinities and a half-life of 3.8 days. It is not transported any significant distance in groundwater and its concentration in a well is directly controlled by the lithology of the aquifer solids adjacent to the well. Numerous studies of radon in groundwater have shown that small public water supplies and private wells have the highest levels of Rn. This is apparently due to the relationship between system size and aquifer composition or rock type. (See also W91-03366) (Agostine-PTT)
W91-03372

OCCURRENCE OF RADIONUCLIDES IN DRINKING WATER, A NATIONAL STUDY.
Environmental Protection Agency, Cincinnati, OH. Office of Administration and Resources Management.
J. Longtin.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 97-139. 8 fig, 11 tab, 8 ref.

Descriptors: *Data collections, *Distribution patterns, *Drinking water, *Geochemistry, *Radioisotopes, *Surveys, *Water pollution sources, Baseline studies, Geography, Groundwater, Political aspects, Water quality control, Water quality standards.

The results of the National Inorganics and Radionuclides Survey (NIRS) are reviewed to develop some perspective on the national occurrence of radon in drinking water originating from groundwater sources. The study, which was conducted by the Environmental Protection Agency (EPA), is compared to previous experience. Included in the discussion are radium, radon, and uranium. The geographical scope of the survey included the United States, its territories and possessions. The universe of community groundwater supplies is inventoried in the EPA Federal Reporting Data System (FRDS) database. A random sample of 1000 sites, stratified into four population categories, was selected from this inventory. The actual sampling was done between July 1, 1984, and October 331, 1986. Samples and site data were collected by state personnel regularly employed in sampling for monitoring drinking water quality. The physical samples were supplemented by collecting a variety of site information which included the following: (1) NIRS sample number, (2) FRDS public water supply identification number, (3) Location information, (4) Site information and (5) Well information (for individual wells in system). Despite the fact that a comprehensive study of the data has not yet been done, sufficient appraisal has been concluded to demonstrate that general agreement exists between NIRS and previous data. Extensive site and quality control information augmenting the results will permit the NIRS results to be used for a variety of purposes. The survey has yielded an important database that will complement existing information and assist understanding of the occurrence of radionuclides in the United States. (See also W91-03366) (Agostine-PTT)
W91-03373

GASTROINTESTINAL ABSORPTION OF SOLUBLE URANIUM FROM DRINKING WATER BY HUMANS.
Utah Univ., Salt Lake City. Environmental Radiation Lab.
M. E. Wrenn, N. P. Singh, H. Ruth, M. L. Rallison, and D. P. Burleigh.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 159-163. 2 fig, 1 tab, 8 ref. U.S. EPA Contract CR-812681-01-03.

Descriptors: *Absorption, *Drinking water, *Gastrointestinal absorption, *Human physiology, *Path of pollutants, *Uranium, Alpha spectrometry, Analytical methods, Radioisotopes, Synergistic effects.

An experiment was conducted to determine the gastrointestinal (GI) absorption of soluble uranium from drinking water by humans. The GI absorption of U in humans may be affected by the concurrent consumption of food. The gastrointestinal absorption of uranium has been measured in ten normal healthy adult volunteers of both sexes by feeding them 1 L of water containing 200-300 microgram of uranium per liter. The water was consumed during normal daytime activities while food was also ingested at its normal rate. Complete collections of urine and feces were made and composited on a daily basis over a period of two weeks, one week being prior to the consumption of the uranium containing water. Uranium was measured by radiochemical separation followed by alpha spectrometry. Both U-234 and U-238 were determined. The results on these people showed that the uptake of uranium under these conditions averaged 0.6%, well below the 5% fraction of U absorbed recommended by the International Commission on Radiological Protection. (See also W91-03366) (Agostine-PTT)
W91-03375

PUBLIC HEALTH AND SLUDGE UTILIZATION: PART II.
Agricultural Research Service, Beltsville, MD. Soil-Microbial System Lab.
R. L. Chaney.
Biocycle BCYCDK, Vol. 31, No. 10, p 68-73, October 1990. 16 ref.

Descriptors: *Cadmium, *Land disposal, *Path of pollutants, *Public health, *Sludge utilization, Agriculture, Bioaccumulation, Heavy metals, Sludge disposal, Waste disposal.

Crops differ in relative cadmium uptake even though all approach a plateau with increasing sludge application rate. Lettuce and spinach have a high response, while beans, rice, and many other crops take up little cadmium even when soil levels are high. Cadmium slowly accumulates in the human kidney throughout life. In the U.S., the public reaches (by age 50) an average kidney cadmium level about one-tenth of that required to cause the first symptoms of cadmium poisoning in most sensitive part of the population. In estimating the effect of sludge utilization on cadmium intake from garden vegetables, the ability of different food groups to accumulate soil cadmium must be considered. The crop in each food group with the highest cadmium uptake was used to estimate the increased cadmium uptake for the whole food group. By using the actual amounts in high cadmi-

um uptake crops such as lettuce and spinach, and the uptake slopes for this subset of leafy vegetables, it was found that estimated increased dietary cadmium from garden leafy vegetables was only about half the apparent risk estimated by the Environmental Protection Agency. Another factor which must be considered in assessing risk from sludge-applied cadmium is bioavailability. Just because increased cadmium is eaten in foods doesn't mean that the cadmium will be absorbed by the intestine at the same level as when cadmium salts are added to the diet. Data from a study in which swiss chard was grown (using three different sludges and a control) shows that cadmium in the chard in one treatment was five times higher than that in the control crop. However, when this chard was fed for a long period to guinea pigs, there was no change in cadmium levels in the kidney or the liver of these animals. Careful estimation of the potential increase in dietary cadmium garden vegetables grown on sludge-fertilized soils shows that the risk may have been overstated. Individuals who actually eat model amounts of garden vegetables have a very good diet and are not going to be the nutrient-deficient people who are at the highest risk from dietary cadmium. A peer review of the EPA 503 draft regulations for sludge management has noted defects in the regulation. The most important flaws were caused by misuse or miscollection of data for crop uptake of metals, crop tolerance of metals, livestock accumulation, and other transfer paths. The proposed regulation also does not presently have a pH-control requirement even though pH is the most important single factor affecting metal transfer and toxicity. (Lantz-PTT)
W91-03384

IMPACT OF ANIMAL WASTE LAGOONS ON GROUND-WATER QUALITY.
Delaware Agriculture Experiment Station, Newark.
W. F. Ritter, and A. E. M. Chirnside.
Biological Wastes BIWAED, Vol. 34, No. 1, p 39-54, 1990. 8 fig, 6 tab, 8 ref.

Descriptors: *Animal wastes, *Farm wastes, *Groundwater pollution, *Lagoons, *Path of pollutants, *Waste disposal, *Wastewater treatment, *Water pollution sources, Ammonium, Chlorides, Delmarva Peninsula, Dissolved solids, Drainage, Loam, Monitoring wells, Nitrates, Nitrogen compounds, Sand, Soil properties, Water table.

Groundwater quality was monitored for three years at two sites around clay-lined animal waste lagoons on the Delmarva Peninsula. A swine waste lagoon located in an Evesboro loamy sand soil (excessively well-drained) was having a severe impact on groundwater quality. Ammonium nitrogen concentrations above 1000 mg/L N have been measured in shallow monitoring wells around the lagoon. Chloride and total dissolved solids concentrations were also high. At the second site which has three lagoons and a settling pond in poorly drained soils, some seepage was occurring. Ammonium nitrogen, nitrate nitrogen, chloride and total dissolved solids were above background concentrations in some of the monitoring wells. There was a strong correlation between nitrate nitrogen and chloride concentrations in the monitoring wells. The results indicated that clay-lined animal waste lagoons located in sandy loam or loamy sand soils with high water tables may lead to the degradation of groundwater quality. (Author's abstract)
W91-03386

POLYCHLORINATED BIPHENYLS IN LAKE MICHIGAN TRIBUTARIES.
Wisconsin Univ.-Madison. Water Chemistry Program.
E. A. Marti, and D. E. Armstrong.
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 3, p 396-405, 1990. 5 fig, 2 tab, 43 ref. EPA Cooperative Agreement 807836010. NOAA Federal Grant NA800-AA-D-00086.

Descriptors: *Aroclors, *Lake Michigan, *Path of pollutants, *Polychlorinated biphenyls, *Tributaries, *Water pollution sources, Bottom sediments, Fluvial sediments, Gas chromatography, Particulate matter, Pollutant identification, Suspended solids.

Polychlorinated biphenyl (PCB) concentrations were measured by gas chromatography in 14 major tributaries to Lake Michigan in samples collected in 1980-1983. Mean total PCB concentrations ranged from 7 to 103 ng/L and were related to evidence of river or sediment contamination. Aroclor 1242/1248-like mixtures were dominant. Association of PCBs with suspended particulate matter averaged 53 to 83% and was influenced by suspended particulate matter concentration and PCB mixture composition. Enhanced association of highly chlorinated PCBs with particulate matter may retard transport. Resuspension of contaminated bottom sediments contributed to the PCB loading transport by rivers. However, high suspended sediment concentrations increased the proportion of the PCBs associated with suspended particulate matter which should enhance retention of PCBs by deposition in near-shore sedimentation zones in lakes. (Author's abstract)
W91-03404

COMPARISON OF MEASURED AND SIMULATED FLOWS DURING THE 15 DECEMBER 1987 DETROIT RIVER FLOW REVERSAL.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 2E.
W91-03406

TOXICITY OF SEDIMENTS FROM WESTERN LAKE ERIE AND THE MAUMEE RIVER AT TOLEDO, OHIO, 1987: IMPLICATIONS FOR CURRENT DREDGED MATERIAL DISPOSAL PRACTICES.
Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 5C.
W91-03409

MONITORING RIVER PLUME TRANSPORT AND MESOSCALE CIRCULATION IN GREEN BAY, LAKE MICHIGAN, THROUGH SATELLITE REMOTE SENSING.
Wisconsin Univ.-Madison. Environmental Remote Sensing Center.
R. G. Lathrop, J. R. Vande Castel, and T. M. Lillesand.
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 3, p 471-484, 1990. 10 fig, 2 tab, 21 ref.

Descriptors: *Eutrophication, *Green Bay, *Lake Michigan, *Limnology, *Path of pollutants, *Plumes, Remote sensing, Satellite technology, Suspended solids, Transparency.

The transport and fate of the Fox River plume and the general circulation patterns within Lake Michigan's Green Bay were investigated using satellite remote sensing imagery (Landsat TM and NOAA AVHRR). The calibrated satellite water color and thermal imagery showed the extreme lower portion of the bay as a distinct water mass (due to the influx of the Fox River) with a steep gradient in water transparency and surface temperature within the first 10 km from the river mouth. Fox River water and its heavy load of suspended and adsorbed material is advectively transported up along the bay's eastern shore in the form of a plume. Significant mixing of Fox River water is not restricted to the extreme lower portion of the bay but also occurs in the middle portions of the bay. Similar water transparency but a distinct difference in thermal structure at the frontal zone between the Green Bay and Lake Michigan water masses indicated that materials entering from the Fox River are largely retained within the bay rather than transported to the open waters of Lake Michigan. (Author's abstract)
W91-03410

INVESTIGATION OF NONPOINT SOURCE POLLUTION ASSOCIATED WITH KARST AQUIFER SYSTEMS.
Western Kentucky Univ., Bowling Green. Dept. of Health and Safety.
W. D. Green, L. P. Elliott, and N. C. Crawford.
Transactions of the Kentucky Academy of Science TKASAT, Vol. 51, No. 3/4, p 177-181, 1990. 1 fig, 2 tab, 21 ref.

Descriptors: *Groundwater pollution, *Karst, *Kentucky, *Nonpoint pollution sources, *Path of pollutants, Animal wastes, Bioindicators, Biological studies, Colonization, Escherichia coli, Fecal coliforms, Fecal streptococci, Groundwater movement, Membrane filters, Septic wastewater, Wastewater pollution.

Karst terrains are very susceptible to pollution from many sources due to rapid recharge into and fast flow rates within conduit systems. Most of Bowling Green, Kentucky, is located within the Lost River Karst Groundwater Basin where conduit flow is the predominant form of underground water transport. Therefore, this area is an ideal location for an investigation of nonpoint source problems associated with karst aquifer systems. Fecal coliforms (FC) and fecal streptococci (FS) from groundwater in the Lost River system were isolated on membrane filters (MF) and subsequently identified by means of API systems appropriate for FC and FS. All typical streptococcal colonies were identified as FS by the 20S system. However, only 92.1% of the FC colonies were identified as Escherichia coli by the 20E system, with the prevalent biovars being implicated as pathogens. Colonies producing falsely positive FC reactions on MF were identified by the 20E system as members of the genera Acinetobacter, Citrobacter, Enterobacter, and Klebsiella. There were many FC/FS ratios > 4.0 and fewer but frequent FC/FS ratios of 0.4, indicating contamination from, respectively, septic tanks and animals. Clostridium perfringens was also present. These data indicate fecal contamination of the Lost River system and present the first verification of the isolation on MF of FS from a karstic aquifer. (Author's abstract)
W91-03435

USING SOIL AND METEOROLOGIC DATA BASES IN UNSATURATED ZONE MODELING OF PESTICIDES.
Environmental Research Lab., Athens, GA.
R. F. Carsel, and R. L. Jones.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 4, p 96-101, Fall 1990. 2 tab, 43 ref.

Descriptors: *Aeration zone, *Databases, *Mathematical models, *Model studies, *Path of pollutants, *Pesticides, *Soil contamination, Data collections, Data requirements, Meteorological data collection, Pesticide transport, Root zone, Soil texture, Soil water.

Soil and meteorologic data bases have been used in the mathematical modeling of pesticide transport and transformation in the unsaturated zone. The Pesticide Root Zone Model (PRZM) was used to demonstrate the use of existing data bases and estimation techniques in developing parameter sets for modeling. Input data required by PRZM include meteorologic, soil, pesticide, crop, and hydrologic information. Pesticide concentration profiles typically are available from monitoring studies; however, soil-water retention or meteorologic data are usually lacking. Meteorologic information collected by the National Oceanic and Atmospheric Administration from stations located throughout the United States can be used in PRZM. PRZM requires data on four major soil characteristics: field capacity, wilting point, organic matter, and bulk density. In the absence of site-specific data, approximations may be obtained utilizing Soil Conservation Service county soil surveys, a Soils Information Retrieval System, or generalized values based on textural classification of soils. PRZM and most other unsaturated zone models describe pesticide transport with a simple retardation equation using the soil partition coefficient. PRZM has been used with soil and meteorological data bases in a variety of simulation techniques including site-specific, soil-specific, regional, stochastic, and saturated/unsaturated zone simulations. (MacKeen-PTT)
W91-03446

GROUND WATER MONITORING AT WELLHEAD PROTECTION AREAS.

Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W91-03447

SOIL-GAS SURVEYING FOR SUBSURFACE GASOLINE CONTAMINATION USING TOTAL ORGANIC VAPOR DETECTION INSTRUMENTS: PART II. FIELD EXPERIMENTATION.
Connecticut Univ., Storrs. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 5A.
W91-03448

PRELIMINARY DELINEATION OF CONTAMINATED WATER-BEARING FRACTURES INTERSECTED BY OPEN-HOLE BEDROCK WELLS.
Geological Survey, Albany, NY.
J. H. Williams, and R. W. Conger.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 4, p 118-126, Fall 1990. 8 fig, 19 ref.

Descriptors: *Aquifer testing, *Geophysical surveys, *Groundwater pollution, *Path of pollutants, Bedrock, Geologic fractures, Groundwater movement, Logging (Recording), Mahopac, New York, On-site investigations, Open wells, Spring Valley, Volatile organic compounds, Water sampling, Wells.

Contaminated water-bearing fractures intersected by open-hole bedrock wells were preliminarily delineated through a combination of geophysical logging, vertical-flow measurements, and downhole water sampling as part of remedial site investigations at two sites in southeastern New York. The wells investigated range from 100 to 450 ft in depth, have only shallow surface casing, and intersect multiple water-bearing zones. The distribution of water-bearing zones that intersect the wells was determined from single-point resistance, caliper, fluid-resistivity, temperature, and acoustic-televiewer logs. Measurable flow in the wells was downward from upper producing zones to lower receiving zones that are poorly connected in the aquifer and that differ in hydraulic head as a result of nearby pumping. A downhole sampler was used to collect discrete and composite water samples for analysis of volatile organic compounds from producing zones that are self-purging as a result of flow from the wells. At the Spring Valley wellfield, a supply well completed in Mesozoic sandstone and conglomerate intersects water-bearing zones at depths of 204 to 245 ft that produced contaminated water that was received by a zone at 278 ft. Most of the water-bearing zones are bedding-plane separations that probably provide pathways for contaminant transport in the bedrock aquifer for significant distances. In the Mahopac business district site, a deep test well completed in Precambrian gneiss intersected shallow water-bearing zones at 50 to 79 ft that produced contaminated water that was received by deep zones at 260 and 328 ft. The water-bearing zones consist of single or closely spaced multiple fractures with dips of 5 to 50 degrees. The methods presented can be applied in existing open-hole wells for preliminary investigation of groundwater flow and contamination in fractured bedrock-aquifers. (Author's abstract)
W91-03449

TEMPORAL VARIATIONS OF CHLORINATED SOLVENTS IN ABSTRACTION WELLS.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
M. O. Rivett, D. N. Lerner, and J. W. Lloyd.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 4, p 127-133, Fall 1990. 9 fig, 1 tab, 13 ref.

Descriptors: *Chlorinated hydrocarbons, *Groundwater pollution, *Path of pollutants, *Pump wells, *Water quality monitoring, Aquifer testing, Birmingham, England, Organic solvents, Temporal distribution, Water quality trends.

Data obtained during an organic water quality survey of abstraction (pumping) wells in the Triassic Sandstone Aquifer of Birmingham, England indicated that there were important variations of chlorinated solvent concentrations with time. Short-term observation of solvent concentrations with elapsed pumping time indicated widely differing well responses; such observations are important in establishing good sampling protocols. Long-term monitoring indicated that solvent concentrations, particularly trichloroethene, were often stable with time. When large variations did occur, these were shown to be due to the variation in the abstraction history of the well or to significant migration of solvent plumes during the monitoring period. Solvent plume migration was particularly exemplified by rising trends in 1,1,1-trichloroethane concentrations. The changes observed in solvent concentrations during long-term monitoring of the Birmingham Aquifer were slow to occur, but often large. The data indicate that abstraction wells may be used to provide valuable information on the degree and trend of groundwater pollution by chlorinated organic solvents. (Author's abstract)
W91-03450

HYDROGEOLOGY OF THE BRUNSWICK (PASSAIC) FORMATION AND IMPLICATIONS FOR GROUND WATER MONITORING PRACTICE.
Deutsche Veterinaermedizinische Gesellschaft e.V., Giessen (Germany, F.R.).
For primary bibliographic entry see Field 2F.
W91-03451

SOME ECOLOGICAL FACTORS IN THE DEGRADATION OF 2,4-DICHLOROPHENOL IN WATERS FROM AQUATIC ENVIRONMENTS.
Tokyo Univ. of Agriculture and Technology (Japan). Dept. of Environmental Science and Conservation.
S. Nakano, and M. Seto.
Japanese Journal of Limnology RIZAAU, Vol. 51, No. 3, p 155-161, 1990. 5 fig, 3 tab, 15 ref.

Descriptors: *Aquatic bacteria, *Biodegradation, *Chlorinated hydrocarbons, *Dichlorophenols, *Fate of pollutants, Microbiological studies, Most probable number test, Nutrient requirements, Population density, Water sampling.

The relationship between the degradation of 2,4-dichlorophenol (DCP) and changes in the density of DCP-degrading microorganisms was examined in water samples from aquatic environments. Water samples were collected from a pond, swamp, lake, and spring, spiked with DCP, and analyzed by high performance liquid chromatography for DCP level. The density of DCP-degraders was determined by a most probable number method. In most of the water samples, the rapid degradation of 0.1 or 1.0 microg DCP-C/ml was observed, after a lag period lasting more than a week, when DCP-degraders had increased to 1000-10,000 or 10,000-100,000 cells/ml, respectively. However, in the water sample from the spring degradation of 0.1 microg DCP-C/ml was not observed in a 42-day incubation, although DCP-degraders had increased to 10,000 cells/ml at day 35 of incubation. When both nitrogen and phosphorous were added to the spring water sample, rapid degradation of DCP was observed. The results suggested that sufficient increase in the density of DCP-degraders was a prerequisite condition for the degradation of DCP, but ecological factors such as mineral nutrient concentrations might limit the activity of DCP-degraders even when their densities were high. (Author's abstract)
W91-03454

EFFECT OF AIR POLLUTION CHEMICAL COMPONENTS ON THE ACIDITY OF RAIN WATER IN JAPAN.
Kobe Women's Coll. of Pharmacy (Japan).
A. Adachi, Y. Asaka, M. Ozasa, N. Sawai, and T. Kobayashi.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 4, p 495-499, October 1990. 2 fig, 1 tab, 6 ref.

Descriptors: *Acid rain, *Anions, *Cations, *Chemistry of precipitation, *Hydrogen ion concentration, *Japan, *Neutralization, *Path of pollutants, *Water pollution sources, Acidity, Air pollution, Air pollution effects, Ammonium, Calcium, Conductivity, Magnesium, Nitrates, Sodium, Sulfates.

Acid rain has recently become a serious environmental problem in Japan. To determine the effects of various kinds of air polluted chemical components on the acidity of rain water (pH), electric conductivity and cationic and anionic ions in rain water collected from an industrial and a residential area in the southern part of Hyogo prefecture in Japan, was compared. In almost all cases, the pH value of the rain water collected from the industrial area was higher than those from the residential area, with the mean pH in rain water of the industrial area 6.3; the residential area had a mean pH of 5.8. This was a discrepancy, because air pollution in industrial areas is generally heavier than in residential areas. In order to clarify this discrepancy, the ions in the rain water were assayed. The results showed that the concentrations of cations--$NH_4(+)$, $Ca(2+)$, $Na(+)$, and $Mg(2+)$--in industrial area rain were significantly higher than those in residential area rain. Total cation levels in the rain water collected from the industrial areas were about 2 times higher than those from the residential area, suggesting that these cations neutralized the acidic anions--$SO_4(2-)$ and $NO_3(-)$. (Mertz-PTT)
W91-03464

DETERMINATION OF TRACE CONCENTRATIONS OF VOLATILE ORGANIC COMPOUNDS IN GROUND WATER USING CLOSED-LOOP STRIPPING, EDWARDS AQUIFER, TEXAS.
Geological Survey, Austin, TX.
For primary bibliographic entry see Field 5A.
W91-03465

MUTAGEN FORMATION AND NITRATION BY EXPOSURE OF PHENYLPHENOLS TO SUNLIGHT IN WATER CONTAINING NITRATE OR NITRITE ION.
Science Univ. of Tokyo (Japan). Faculty of Pharmaceutical Sciences.
J. Suzuki, T. Sato, A. Ito, and S. Suzuki.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 4, p 516-522, October 1990. 4 tab, 15 ref.

Descriptors: *Mutagens, *Path of pollutants, *Phenols, *Photochemistry, *Photolysis, *Water pollution sources, Aromatic compounds, Chemical reactions, Degradation, Nitrates, Nitrites, Solar radiation, Ultraviolet radiation, Water pollution.

Mutagens in aquatic environments are considered to be attributable not only to the inflow of industrial effluent and domestic sewage containing mutagens, but also chemical to the and biological transformation of organic pollutants to mutagens. Photochemical reactions of aromatics with nitrate or nitrite ions may be an important cause of the mutagens in aquatic environments. However, it is uncertain whether photochemical mutagen formation is caused by sunlight, because earlier studies were undertaken by irradiating ultraviolet light derived from a high-pressure mercury lamp. To clarify this uncertainty, phenylphenols, which are used for the storage of citrus fruits as a fungicide, were exposed to sunlight for 2-8 weeks during the summer in neutral aqueous nitrate and nitrite solutions. Phenylphenols were nitrated and converted to a mutagen by exposure to sunlight in water containing nitrite ions. The mutagen formed was direct-acting as shown by the fact that the mutagenicities of the ether extracts were depressed with metabolic enzymes in rat liver. Photochemical mutagen formations by exposure to sunlight did not occur in aqueous nitrate solutions and the nitration of phenylphenols in aqueous nitrate solution was slow compared with that in an aqueous nitrite solution. The degradation of phenylphenols were observed to the same degree in either nitrate or nitrite solution, indicating that the photolysis of phenylphenols was independent of the photolysis of nitrate and nitrite ions. This implies that the

nitration and the mutagen formation are governed only by photolysis of nitrate and nitrite ions and independent of the photo-degradation of phenylphenols. Consequently, the most important factor for photochemical mutagen formation in the aquatic environment is the concentration level of nitrite ion. (Mertz-PTT)
W91-03466

TRACE METALS IN TROPICAL COASTAL LAGOON BIVALVES, CRASSOSTREA CORTEZIENSIS.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ciencias del Mar y Limnologia.
F. Paez-Osuna, and C. Marmolejo-Rivas.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 4, p 538-544, October 1990. 3 fig, 1 tab, 15 ref. Consejo Nacional de Ciencias y Tecnologia de Mexico Project PCCBBNA 021995.

Descriptors: *Heavy metals, *Oysters, *Path of pollutants, *Trace metals, Bioaccumulation, Cadmium, Chromium, Cobalt, Copper, Iron, Lagoons, Lead, Manganese, Mollusks, Nickel, Seasonal variation, Water pollution, Zinc.

The Mangrove oyster Crassostrea corteziensis is a brackish species that is geographically distributed from the Gulf of California to the North of Peru. Along the Pacific coast of Mexico, this mollusk is widely utilized for human consumption. The accumulation of nine trace metals (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) from lagoonal water by the oyster C. corteziensis during a 12-month period from the Port of Mazatlan, Mexico was examined. The levels of Fe, Mn, Cd and Cr were relatively constant, while levels of Ni, Co and Pb simultaneously showed an enrichment in the autumn-winter months, when temperatures of seawater decreased from 30-32 C to 22-24 C. The relationships between some metals in C. corteziensis were significant. For Zn and Cu, the linear correlation coefficient was 0.85; for Mn-Fe, the linear coefficient was 0.61; for Co-Cr, 0.80; Cd-Ni, 0.71, Co-Ni, 0.92; and Ni-Pb, the linear coefficient was 0.70. Seasonal fluctuations with highest values in the autumn-winter months have been found in other species of bivalves. These results show that the relationships found are valuable because it is possible to estimate the concentration factor and the concentration of metals in water that is likely to cause the elements to accumulate in bivalves to undesirable concentrations. (Mertz-PTT)
W91-03467

TRACE METALS IN TROPICAL COASTAL LAGOON BIVALVES, MYTELLA STRIGATA.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ciencias del Mar y Limnologia.
C. Marmolejo-Rivas, and F. Paez-Osuna.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 4, p 545-551, October 1990. 3 fig, 1 tab, 15 ref. Consejo Nacional de Ciencia y Tecnologia de Mexico Project PCCBBNA-0210995.

Descriptors: *Heavy metals, *Manganese, *Mussels, *Path of pollutants, *Trace metals, Bioaccumulation, Cadmium, Chromium, Cobalt, Copper, Iron, Lagoons, Mollusks, Nickel, Productivity, Seasonal variation, Water pollution, Water temperature, Zinc.

The tropical mussel Mytella strigata is a lagoonal species that is geographically distributed from the Gulf of California to the south of Salvador and the Galapagos islands in the Pacific, and from Venezuela to Argentina in the Atlantic Ocean. The accumulation of nine trace metals (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) from lagoonal water by the mussel M. strigata during a nine-month period from the Port of Mazatlan, Mexico was examined. Co, Ni and Zn in June, and Pb and Fe in April showed the maximum concentration in the soft tissue of the mussel. Cr, Cu, and Mn had an enrichment in the winter months. It was possible that some of the observed fluctuations of Mn and Cr values were not significant, however, large differences between some months were most likely valid. Cd was relatively constant during the months sampled. The relationships between some metals in the mussel M. strigata were significant. For Cr and Cu, the linear correlation coefficient was 0.73; whereas Mn fluctuated in an inverse manner with Cd with a linear correlation coefficient of -0.63. Seasonal variations, with the highest values in autumn or winter months, have been found in other species of mussels. Seasonal changes in trace metal concentrations have been related to factors such as: food supply associated with an increase of productivity resulting from higher temperatures and longer days during spring and summer; changes in runoff of particulate metal to the sea due to high precipitations; or simply to seasonal size changes in metal content during the year. In M. strigata, no correlations was made with the levels of dissolved metals observed in the lagoonal water, nor with the level of metals in the particulate fraction corresponding to the same collection time. However, a significant relationship was found for the levels of trace elements in the mussel with the particulate fraction of the month immediately preceding for 3 of the 9 metals analyzed. (Mertz-PTT)
W91-03468

DISTRIBUTION OF POLYCHLOROBIPHENYLS AND HEXACHLOROBENZENE IN DIFFERENT TISSUES OF THE DAB (LIMANADA LIMANADA L.) IN RELATION TO LIPID POLARITY.
Hamburg Univ. (Germany, F.R.). Inst. fuer Biochemie und Lebensmittelschemie.
U. Kammann, R. Knickmeyer, and H. Steinhart.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 4, p 552-559, October 1990. 3 fig, 1 tab, 14 ref. Bundesminister fuer forschung und Technologie Project MFU 05765.

Descriptors: *Chlorinated hydrocarbons, *Flatfish, *Lipids, *Path of pollutants, *Polychlorinated biphenyls, Bioaccumulation, Fish physiology, Hexachlorobenzene, Tissue analysis, Water pollution effects.

Cyclic organochlorines are environmentally persistent and widely distributed in marine ecosystems. Fish can accumulate these substances from water and food. The patterns of 26 individual PCB (polychlorobiphenyl) congeners and HCB (hexachlorobenzene) in different organs of female dabs (Limanda limanda L.) were investigated. The influence of total lipid content as well as polar lipid fractions and neutral lipid fraction on the distribution of PCB congeners in the tissues was also studied. All tissues under investigation exhibited a distinct PCB pattern, independent of sampling station and season. PCB patterns of kidney and gallbladders showed large contributions of trichlorobiphenyls and tetrachlorobiphenyls. High amounts of polar lipids in kidneys and gallbladders correlated to increased contributions of more polar trichlorobiphenyls and tetrachlorobiphenyls. Patterns of liver, ovaries, gills and stomach, however, were dominated by pentachlorobiphenyls and hexachlorobiphenyls, PCB 153 and PCB 138. In these tissues large amounts of pentachlorobiphenyls and hexachlorobiphenyls correlated with high amounts of neutral lipids. PCB patterns of the stomach reflect the actual food composition of the dab. The PCB patterns of ovaries were directly influenced by the transfer of liver lipids with a preferred transfer of PCB 138 and 128 from livers to ovaries. At the beginning of the spawning period in February, PCB congeners and hexachlorobenzene contamination of livers exhibited their lowest levels; however, the concentrations of these compounds in the ovaries increased. Maximal PCB-congener and hexachlorobenzene burden in ovaries coincides with a minimum of neutral lipids in female livers. These findings may be explained by a transfer of organochlorines from livers to ovaries during periods of unfavorable food conditions. (Mertz-PTT)
W91-03469

UPTAKE AND RELEASE OF CADMIUM IN VARIOUS ORGANS OF THE COMMON MUSSEL, MYTILUS EDULIS (L).
Nederlands Inst. voor Onderzoek der Zee, Texel.
J. M. Everaarts.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 4, p 560-567, October 1990. 2 fig, 3 tab, 16 ref.

Descriptors: *Bioaccumulation, *Cadmium, *Mussels, *Path of pollutants, Heavy metals, Mollusks, Tissue analysis, Toxicity, Water pollution, Water temperature.

Numerous data on the internal distribution of trace metals in Mytilus edulis have been published. The highest concentration and main body burden of cadmium are reported for the mid-gut gland and the kidney. During 40 days of exposure to 50 microgram cadmium/L at 15 C, cadmium accumulated linearly in mussel kidney to 300 microgram/g dry weight, in the gills to 130 microgram/g dry weight, and in the hepatopancreas to 170 microgram/g dry weight. Cadmium concentrations in the foot, adductor muscle and mantle were relatively low. After 40 days exposure at 20 C, cadmium accumulation in the kidney, gill, mantle and adductor muscle was a factor of 2.2 to 2.7 higher than at 15 C. The depuration of cadmium was measured at 20 C. Concentrations decreased according to a first order reaction: a rapid release during the first four days of exposure to clean seawater and a more gradual loss thereafter until a level of equilibrium was reached. Release of cadmium did not continue until the original control level was reached. This was possibly due to cadmium binding to metal binding proteins, hampering the excretion of the metal-rich residual bodies. After exposure for 9 days to an estimated dose of 180 microgram Cd/L, and a subsequent recovery period of 28 days in clean seawater, the amount of Cd bound to thioneine in the digestive gland of Mytilus galloprovincialis at the end of the recovery period had increased by approximately 250%. These data demonstrate the importance of methallothionein induction in the reduction of the cytotoxic effects exerted by high levels of Cd accumulation. (Mertz-PTT)
W91-03470

TRANSFER OF TOXIC CONCENTRATIONS OF SELENIUM FROM PARENT TO PROGENY IN THE FATHEAD MINNOW (PIMEPHALES PROMELAS).
Environmental Research Lab.-Duluth, Monticello, MN. Monticello Ecological Research Station.
For primary bibliographic entry see Field 5C.
W91-03471

DETOXIFICATION OF COPPER BY NITZSCHIA OBTUSA WN. SM., A PENNATE DIATOM.
Madras Univ. (India). Centre of Advanced Study in Botany.
K. P. Gowrinathan, and V. N. R. Rao.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 4, p 612-618, October 1990. 3 fig, 2 tab, 17 ref.

Descriptors: *Biochemistry, *Detoxification, *Heavy metals, *Path of pollutants, *Phytoplankton, *Toxicology, Algae, Biological wastewater treatment, Diatoms, Fate of pollutants, Wastewater treatment.

Phytoplankton have the ability to detoxify metals to survive in water laden with high concentrations of heavy metals. Adaptations of algae to an unfavorable metal environment include the exclusion of heavy metals by binding metals outside the cell with extracellular materials such as polypeptides, polysaccharides and hydroxamates that have metal binding sites. Possible detoxification mechanisms in Nitzschia obtusa Wm.Sm. to copper were determined by analyzing whole cells without EDTA washing (showing 0.13 microgram of Cu/1,000,000 cells). Approximately 30% of the Cu that disappeared from the medium was adsorbed on the surface of the cells. A reduction in the amount of metal in the cytosolic fraction of the cells may be due to a binding of Cu to the membranes of intracellular inclusions. Two mechanisms for tolerance were encountered: (1) adsorption of cations

on the cell surface, and (2) formation of methallothionein-like protein complex in the cytoplasm of cells. More studies on the detoxification mechanisms exhibited by diatoms in response to various metals may help to evolve a biological treatment system for industrial effluents containing high amounts of heavy metals. (Mertz-PTT)
W91-03474

SANITARY AND BACTERIAL ANALYSIS OF WATER AND BOTTOM SEDIMENTS OF A HEAVILY POLLUTED, HYPERTROPHIC LAKE.
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Dept. of Ecology and Freshwater Biology.
S. Niewolak.
Ekologia Polska ELPLBS, Vol. 37, No. 1/2, p 3-30, 1989. 8 fig, 9 tab, 55 ref.

Descriptors: *Lake Beskie, *Lake sediments, *Poland, *Water pollution sources, *Water quality, Agricultural runoff, Algal blooms, Bacteria, Bioindicators, Coliforms, Farm wastes, Fecal coliforms, Fecal streptococci, Seasonal variation, Wastewater farming, Water pollution, Water temperature.

The development of cattle and pig fattening farms constitutes a serious threat to the cleanliness of lakes. Particularly dangerous are the slurry wastes if applied in excess to crop-fields, meadows and pastures. Sanitary and bacteriological studies of a hypertrophic Lake Beskie, in the Masurian Lakeland, Poland, were carried out during 1982-1984. Values for total number of bacteria, total number of coliforms, number of fecal coliforms and number of fecal streptococci were determined for four different sites, at different depths and at temperatures between 20 and 37 C. The degree of pollution of water and bottom sediments varied between the sampling sites, study years, and over a yearly cycle. Bacterial pollution in the water and bottom sediments was higher near sewage discharge sites. Bacterial pollution was also higher in 1982, when livestock numbers in the catchment area were twice as high, compared with 1983 and 1984. Consequently, slurry wastes, with which crop-fields, meadows and pastures were treated, was greatly increased during 1982. Over a yearly cycle, indicator bacteria were higher in spring, summer and autumn, compared with winter. Bacteria numbers were also higher following a storm or long-lasting rainfalls. Lower bacteria numbers were recorded during algal blooms and death. (Mertz-PTT)
W91-03476

AIR QUALITY OF BRAMA MORAWSKA REGION AND TRANSBOUNDARY TRANSPORT OF SULPHUR DIOXIDE.
Instytut Ksztaltowania Srodowiska, Katowice (Poland).
S. Hlawiczka, P. Hallala, and H. Polewko.
Ekologia Polska ELPLBS, Vol. 37, No. 1/2, p 83-95, 1989. 3 fig, 2 tab, 10 ref.

Descriptors: *Acid rain, *Air pollution, *Air pollution sources, *Czechoslovakia, *Path of pollutants, *Poland, *Sulfur dioxide, Cadmium, Dry deposition, Heavy metals, Hydrogen ion concentration, Iron, Lead, Manganese, Nitrates, Pollution load, Sulfates, Zinc.

Air quality was investigated along the southern part of Poland from the Babia Gora in an eastward direction to the western part of the Karkonosze range in the west. The Brama Morawska region was investigated separately because is represents the one broad depression in the mountain range along the border between Poland, Czechoslovakia and Moravia. It is the only possible space (30 km) where an undisturbed transport of polluted air is possible. Over two years of investigations included measurements of daily dust concentrations and analysis for SO2(2-), NO3(-), Zn, Pb, Cd, Mn, and Fe. Measurements of SO2 concentrations in dust fall, rainfall and pH were also performed. An excess of permissible concentrations of suspended dust and Pb was found. The share of SO4(2-) in dust was about 16% and of NO3(-) about 5.5%. The average pH value of rain ranged from 4.8 to 5.2. The annual average dust fall ranged between 50 and 180 ton/square km/year. The rough estimation of loads of some pollutants reaching the soil with dust fall and rainfall was about 10.6 m/square for sulfates and 3.2 g/square m for nitrates. The annual load of SO2 was about 86,500 ton. About 50,000 ton, or 58% of the SO2 load was transported from Czechoslovakia to Poland and about 36,500 ton, or 42%, of the SO2 load was sent back from Poland. (Mertz-PTT)
W91-03480

NITRATE DEPLETION IN THE RIPARIAN ZONE AND STREAM CHANNEL OF A SMALL HEADWATER CATCHMENT.
Department of Scientific and Industrial Research, Hamilton (New Zealand). Water Quality Centre.
A. B. Cooper.
Hydrobiologia HYDRB8, Vol. 202, No. 1/2, p 13-26, August 29, 1990. 3 fig, 4 tab, 46 ref.

Descriptors: *Agricultural runoff, *Denitrification, *Fate of pollutants, *Headwaters, *Riparian land, *Streams, *Surface-groundwater relations, Anoxic conditions, Carbon, Enzymes, Groundwater movement, Hydrological regime, Mass balance, New Zealand, Nitrogen cycle, Organic soils, Plant populations, Soil chemistry, Wetlands.

Processes within riparian wetlands and within stream channels themselves are capable of removing nitrate from agricultural drainage, although the significance of these processes in regulating nitrate flux varies widely. A mass balance procedure was used to determine rates of nitrate depletion in the riparian zone and stream channel of a small New Zealand headwater stream. In all 12 surveys the majority of nitrate loss (56-100%) occurred in riparian organic soils, despite these soils occupying only 12% of the stream's border. This disproportionate role of the organic soils in depleting nitrate was due to two factors: (1) they were located at the base of hollows and consequently a disproportionately high percentage (37-81%) of the groundwater flowed through them in its passage to the stream; and (2) they were anoxic and high in both denitrifying enzyme concentration and available carbon. Direct estimates of in situ denitrification rate for organic soils near the upslope edge were much higher than average values estimated for the organic soils as a whole and suggested that areas of these soils were limited in their denitrification activity by the supply of nitrate. The capacity of these soils to regulate nitrate flux was therefore under-utilized. The majority of stream channel nitrate depletion was apparently due to plant uptake, with estimates of the in situ denitrification rate of stream sediments being less than 15% of the stream channel nitrate depletion rate estimated by mass balance. This study reinforces the view that those seeking to understand the functioning of these ecosystems need to consider hydrological phenomena. (Author's abstract)
W91-03483

GULL CONTRIBUTIONS OF PHOSPHORUS AND NITROGEN TO A CAPE COD KETTLE POND.
Cape Cod National Seashore, South Wellfleet, MA.
J. W. Portnoy.
Hydrobiologia HYDRB8, Vol. 202, No. 1/2, p 61-69, August 29, 1990. 2 fig, 5 tab, 24 ref.

Descriptors: *Animal wastes, *Eutrophic lakes, *Eutrophication, *Gulls, *Limnology, *Massachusetts, *Nitrogen, *Phosphorus, *Ponds, Aquatic productivity, Cape Cod, Excretion, Migration, Nutrients, Water pollution sources.

Phosphorus (P) and nitrogen (N) and their sources have received widespread study because of their key roles in algal and macrophyte nutrition. The estimation of P loading rates has become an accepted approach for predicting lake productivity as well as a management tool for controlling cultural eutrophication in disturbed watersheds. Nutrient excretion rates and the annual contribution of P from the feces of the gulls Larus argentatus and L. marinas (and of N from L. argentatus) to the nutrient budget of Gull Pond (Wellfleet, Massachusetts), a soft water seepage lake, have been estimated. Intensive year-round gull counts by species were combined with determinations of defecation rate and the nutrient content of feces to quantitatively assess the P loading rates associated with regular gull use of this coastal pond on a seasonal and annual basis. Total P loading from gulls was estimated to be 52 kg/yr, with 17 kg from L. argentatus and 35 kg from L. marinus, resulting from about 5,000,000 h/yr and 1,700,000 h/yr of pond use. This compares with P loading estimates of 67 kg/yr from upgradient septic systems, 2 kg/yr from precipitation and 3 kg/yr from unpolluted groundwater. Fifty-six percent of annual gull P loading was associated with migratory activity in late fall. Estimated annual N loading by L. argentatus was 14 kg total kieldahl 206 g NO3-N, and 1.85 g NH3-N. (Author's abstract)
W91-03484

HEAVY METAL AND PCB CONTAMINATION OF BRYOZOAN COLONIES IN THE RIVER MEUSE (BELGIUM).
Liege Univ. (Belgium). Lab. of Animal Morphology.
V. Henry, J. C. Bussers, J. M. Bouquegneau, and J. P. Thome.
Hydrobiologia HYDRB8, Vol. 202, No. 3, p 147-152, August 31, 1990. 2 fig, 1 tab, 19 ref.

Descriptors: *Belgium, *Bioaccumulation, *Biomass, *Bryozoans, *Ecosystems, *Heavy metals, *Path of pollutants, *Polychlorinated biphenyls, *Sediment contamination, Animal populations, Aquatic animals, Cadmium, Chromium, Colonization, Copper, Environmental impact, Industrial wastewater, Lead, Meuse River, Nuclear powerplants, Pollution load, River sediments, Water pollution effects, Zinc.

In the Meuse River (Liege area, Belgium), large amounts of three species of Bryozoans, Fredericella sultana (BLUM.), Plumatella emarginata ALL., and Plumatella fungosa (PALL.) occur. They cover 3 to 40% of the bank walls and their biomass ranges from 12 to 293 g/sq-m (dry weight). In the heated waters of a nuclear power plant and of industries lined up along the river, colony development occurs 3 to 4 weeks earlier than at an upstream station. The heavy metal content of living colonies ranges from 4 to 21 mg/kg cadmium, 45 to 182 mg/kg copper, 803 to 2232 mg/kg zinc, 150 to 483 mg/kg lead, and 21 to 138 mg/kg chromium dry weight. The mean concentration of polychlorinated biphenyls (PCBs) was 925 micrograms/kg dry weight. Heavy metal and PCB concentrations in the sediments were close to those of the colonies, suggesting that most of the pollutants found in the Bryozoans is in fact in the sediment trapped by the colonies. (Author's abstract)
W91-03489

HISTORICAL PERSPECTIVE ON THE ENVIRONMENTAL BIOAVAILABILITY OF DDT AND ITS DERIVATIVES TO GULF OF MEXICO OYSTERS.
Texas A and M Univ., College Station. Dept. of Oceanography.
J. L. Sericano, T. L. Wade, E. L. Atlas, and J. M. Brooks.
Environmental Science and Technology ESTHAG, Vol. 24, No. 10, p 1541-1548, October 1990. 6 fig, 3 tab, 41 ref. National Oceanic and Atmospheric Administration, Contract 50-DGNC-5-00262.

Descriptors: *DDD, *DDE, *DDT, *Fate of pollutants, *Gulf of Mexico, *Oysters, *Pesticide residues, *Pesticides, Mollusks, National Status and Trends Survey, Pollutant identification, Surveys.

DDT and its metabolites, DDD and DDE were analyzed in 479 oyster samples from the Gulf of Mexico between 1986 and 1988 as part of the National Status and Trends Mussel Watch Program. DDT and/or its derivatives were found in every sample analyzed in concentrations ranging over 2 orders of magnitude. DDT accounted for 3-6% of the total DDT burden in oysters. The

remaining percentage was approximately equally distributed between DDD and DDE. After the first 3 years of the National Status and Trends Program, the geographical distribution of total DDT along the northern coast of the Gulf of Mexico has been well defined. Based on 3 years of data, there were only a few sites that had statistically significant monotonic changes in concentrations with time. However, when the present data set is compared to historical data for the Gulf of Mexico, a general decrease is observed. The rate of DDT disappearance, as monitored by Gulf of Mexico oysters, is comparable with its decline in other marine environments. (Author's abstract)
W91-03509

DYNAMIC PARTITIONING OF ORGANIC CHEMICALS IN REGIONAL ENVIRONMENTS: A MULTIMEDIA SCREENING-LEVEL MODELING APPROACH.
California Univ., Los Angeles. Dept. of Chemical Engineering.
Y. Cohen, W. Tsai, S. L. Chetty, and G. J. Mayer.
Environmental Science and Technology ESTHAG, Vol. 24, No. 10, p 1549-1558, October 1990. 3 fig, 5 tab, 68 ref. EPA agreement CR-812271-03.

Descriptors: *Chlorinated hydrocarbons, *Fate of pollutants, *Model studies, *Path of pollutants, California, Dry deposition, Rainfall, Runoff, Vadose zone, Water pollution.

A screening-level spatial-multimedia-compartmental approach to modeling the fate and transport of volatile organic pollutants in regional environments was developed. The screening-level spatial-multimedia-compartmental approach, which makes use of both uniform (for example, well-mixed) and nonuniform (one-dimensional) compartments, incorporates a variety of transport phenomena associated with pollutant transport such as dry deposition, rain scavenging, runoff, infiltration, soil drying, and pollutant diffusion and convection in the vadose zone. The multimedia distributions of trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane in the Los Angeles area, and tetrachloroethylene in the San Diego area, were explored by using the screening-level spatial-multimedia-compartmental model. The predicted concentrations were found to be in reasonable agreement with the available field data. The study suggests that the screening-level spatial-multimedia-compartmental approach is useful and efficient for rapid screening-level analysis of the steady-state or dynamic multimedia distribution of chemical pollutants. (Author's abstract)
W91-03510

PHOTOCATALYTIC DEGRADATION OF ATRAZINE AND OTHER S-TRIAZINE HERBICIDES.
Parma Univ. (Italy). Ist. di Chimica Fisica Applicata.
For primary bibliographic entry see Field 5F.
W91-03511

EFFECTS OF TERRESTRIAL EFFLUENTS ON THE INCIDENCE OF AEROMONAS SPP. IN COASTAL WATERS.
Barcelona Univ. (Spain). Dept. of Microbiology.
R. M. Araujo, R. Pares, and R. Lucena.
Journal of Applied Bacteriology JABAA4, Vol. 69, No. 3, p 439-444, 1990. 6 fig, 2 tab, 15 ref.

Descriptors: *Coastal waters, *Fecal streptococci, *Path of pollutants, *Pathogenic bacteria, *Spain, *Water pollution effects, *Water pollution sources, Bacteria, Bacterial analysis, Fecal coliforms, Pollutant identification, Rivers, Water analysis, Water pollution.

Strains of the Aeromonas hydrophila group are known pathogens of animals, especially fish, frogs and reptiles. They are also considered to be opportunistic pathogens for humans in whom they cause gastroenteritis, bacteremia and external skin and wound infections. The numbers of Aeromonas species were monitored for one year on the Barcelona, Spain coast. Nine stations, 1 m in depth on the Barcelona coast and two stations situated in the Besos and Llobregat river about 3 km from the mouth were sampled monthly for one year. In summer, a further nine stations were also sampled. Their concentrations exceeded those of fecal coliforms and fecal streptococci in all samples, both on the shoreline and at 500 m from the coast. The mean values of the three bacterial counts reflected the proximity of the terrestrial effluents. There was a positive correlation between aeromonads and fecal indicators on the shoreline but not at 500 m offshore. This reflected their common origin and different survival rates in seawater. When sterile sea water was inoculated with A. hydrophila ATCC 7966, the numbers decreased initially by three orders of magnitude before they began to multiply. The final count was related to the concentration of organic matter in the water. (Mertz-PTT)
W91-03521

FATE OF CHLOROTHALONIL IN GROUND WATER IN COMMERCIAL CRANBERRY CULTURE IN THE NEW JERSEY PINE BARRENS.
Cook Coll., New Brunswick, NJ. Dept. of Environmental Science.
G. Winnett, P. Marucci, S. Reduker, and C. G. Uchrin.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 6, p 587-595, August 1990. 2 fig, 2 tab, 6 ref.

Descriptors: *Agricultural chemicals, *Chlorothalonil, *Cranberries, *Groundwater quality, *New Jersey, *New Jersey Pine Barrens, *Path of pollutants, *Pesticides, Bogs, Cohansey aquifer, Monitoring wells, Pesticide residues, Surface water, Water quality monitoring.

The fate of the agricultural pesticide chlorothalonil in groundwater was studied in an experimental cranberry bog in the Pine Barrens, New Jersey. Clusters of monitoring wells were sunk at depths of 0.5, 1.0, and 1.5 m. Chlorothalonil was applied to the experimental bog 3-4 times per growing season at 5-16 pints per acre for 1985-1987. Groundwater and surface waters were sampled weekly or biweekly for two years and samples were analyzed for chlorothalonil residues by gas chromatography. In general, the chlorothalonil treatments to the experimental bog, which followed the recommendation of the New Jersey Agricultural Station to the state's cranberry growers, showed no discernible vertical movement of the pesticide from the surface to the groundwater. In the few cases where there was a groundwater residue, levels were so small and inconsistent that they may have been the result of channeling along the well casing. Instances of chlorothalonil residues in surface waters may be explained by occurrence of a spill and drift of the pesticide during application. Where residues of chlorothalonil were found in the soil, they were limited to the top 1-2 inches. It is concluded that chlorothalonil application to cranberry bogs in the Pine Barrens poses little risk of contaminating the underlying Cohansey aquifer system. (MacKeen-PTT)
W91-03533

ENVIRONMENTAL STUDY ON CHEMICAL POLLUTION OF THE LAKE KORONIA IN NORTHERN GREECE.
Thessaloniki Univ., Salonika (Greece). Lab. of Analytical Chemistry.
G. A. Vasilikiotis, J. A. Stratis, A. N. Voulgaropoulos, G. A. Zachariadis, and B. Michalopoulou.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 6, p 611-620, August 1990. 1 tab, 12 fig, 10 ref.

Descriptors: *Greece, *Heavy metals, *Lake Koronia, *Lakes, *Path of pollutants, *Water pollution sources, Chemical analysis, Conductivity, Eutrophic lakes, Hydrogen ion concentration, Lake sediments, Nutrient concentrations, Surface water.

The chemical pollution of Lake Koronia in the district of Thessaloniki, Greece was surveyed. Surface water and sediment samples were collected over a nine-month period from six sampling stations and tested for chemical and physicochemical parameters including pH, conductivity, temperature, and concentrations of nutrients and heavy metals. Temperatures were similar at all sampling stations, and lake water was slightly alkaline. The ratio of nitrate-N to phosphate-P was significantly elevated and as a result an extended eutrophication was observed. At stations near the site of discharge of untreated wastewater, the concentrations of Hg and Pb were higher than at the other stations; however, levels of these metals in the corresponding sediments were low. An analysis of cold-extractable versus total metals in sediments indicated that all of the Cu and Hg present in sediments was attributable to pollution, whereas most of the Fe originated in the sediment. An investigation into the sources of heavy metal pollution of the lake is recommended. (MacKeen-PTT)
W91-03534

PARAMETER IDENTIFICATION OF SOLUTE TRANSPORT MODELS FOR UNSATURATED SOILS.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
R. Abeliuk, and H. S. Wheater.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 199-224, September 1990. 11 fig, 8 tab, 35 ref.

Descriptors: *Flow models, *Model studies, *Parameterization, *Path of pollutants, *Soil water, *Solute transport, *Unsaturated flow, Conductivity, Dispersion, Sandy soils, Soil moisture, Soil profiles.

In models of unsaturated flow and solute transport, parametric relationships may be used to define material properties, namely the soil moisture characteristic, unsaturated conductivity function and the hydrodynamic dispersion relationship. The application of optimization methods to identify parameter values from experimental data of time-varying vertical profiles of moisture content and solute concentration is investigated for a sandy soil. Multiple local optima are identified for both flow and solute transport relationships, but these alternative parameter sets are shown to be generally more robust in prediction within he range of observed system states, which suggests utility for this approach to parameter identification. Other possible forms of dispersion relationship are investigated, and several different formulations produce identical performance. This indicates that the dispersion relationship is ambiguous and hence the interpretation of analytical form from this type of experimental data may not be possible. (Author's abstract)
W91-03549

MOBILITY TESTS OF PESTICIDES IN AGRICULTURAL SOILS (ESSAIS DE MOBILITE DES PESTICIDES DANS LES SOLS AGRICOLES).
Faculte des Sciences Agronomiques de l'Etat, Gembloux (Belgium).Lab. d'Hyraulique.
S. Dautrebande, M. Polarski, and J. Dewalsche.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 301-321, September 1990. 18 fig, 4 tab, 9 ref. English summary.

Descriptors: *Agricultural chemicals, *Laboratory methods, *Path of pollutants, *Percolation tests, *Pesticides, *Soil columns, Degradation products, Mathematical models, Model studies, Soils, Solute transport.

A laboratory soil column experiment was performed to determine the percolation potential of several pesticides and/or their degradation products in agricultural soils. A convenient model was developed for the systematic analysis of the potential of pesticides in the following processes: (1) degradation on the surface; (2) accumulation in the soil; (3) mobility, both of the original chemical and its degradation products; (4) absorption/desorption; and (5) dispersion. It was possible to relate characteristic parameters for pesticide transfers to a classification of potential risks of their accumulation in groundwater under conditions of medium

infiltration. These differences can be determined in the laboratory for different types of soil and under different conditions of infiltration. It is concluded that experimentation on soil columns in the laboratory may contribute to the development of a systematic methodology for the prediction of the extent of pesticide mobility in soils, either in their initial form or degraded. It would be possible, therefore, to compare the pesticides among themselves and come to a rational selection, especially with regard to the risk of pollution of the groundwater. (Peters-PTT)
W91-03554

VIRAL AND BACTERIAL CONTAMINATION OF MUSSELS (MYTILUS EDULIS) EXPOSED IN AN UNPOLLUTED MARINE ENVIRONMENT.
Institut National de la Sante et de la Recherche Medicale, Nice (France). Unite 303 Mer et Sante.
C. Jehl-Pietri, B. Hugues, and R. Deloince.
Letters in Applied Microbiology LAMIE7, Vol. 11, No. 3, p 126-129, September 1990. 1 tab, 15 ref.

Descriptors: *Coliforms, *Enteroviruses, *Marine pollution, *Path of pollutants, *Shellfish, *Viruses, Coastal waters, Fecal coliforms, Fecal streptococci, Marine environment, Mediterranean Sea, Shellfish contamination.

The contamination of mussels (Mytilus edulis) by fecal bacteria, cell-culturable enteroviruses and hepatitis A virus (HAV) was studied in mussels exposed in an unpolluted marine environment. Mussels were immersed at a depth of 15 m at a site 180 m south of the coastal point known as 'Cap Roux', Alpes-Maritimes, France. Samples were removed every 15 d for 7 mo. Of the 16 mussel samples examined, none contained cell-culturable enteroviruses, four showed a low-level contamination by HAV, and two did not conform to current bacteriological norms. No connection was observed between the viral and bacterial contamination. No viral contamination was detected in the sea water samples, but two gave bacterial counts above current norms. (MacKeen-PTT)
W91-03558

SUPERFUND RECORD OF DECISION: MONTGOMERY TOWNSHIP HOUSING DEVELOPMENT, NJ.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-03561

SUPERFUND RECORD OF DECISION: EWAN PROPERTY, NJ.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-03562

SUPERFUND RECORD OF DECISION: DORNEY ROAD, PA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-03563

ASSESSMENT OF AQUATIC ORGANISMS AS BIOINDICATORS OF HISTORICAL RADIONUCLIDE RELEASE TO THE COLUMBIA RIVER.
Battelle Pacific Northwest Labs., Richland, WA.
D. D. Dauble, T. M. Poston, and R. L. Newell.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-005941. Price codes: AO3 in paper copy, AO1 in microfiche. December 1988. 30p, 1 fig, 4 tab, 48 ref. DOE Contract DE-AC06-76RLO 1830.

Descriptors: *Bioaccumulation, *Bioindicators, *Columbia River, *Radionuclides, *Strontium, Mussels, Whitefish.

The potential for using several aquatic organisms as biological indicators of historic levels of radionuclides released to the Hanford Reach of the Columbia River was examined. The purpose of the study was to determine the types of environmental samples that could be collected to further the understanding of previous releases of radionuclides at Hanford. Information was initially collected to determine the relative abundance and persistence of radionuclides historically released at Hanford. The potential for long-lived radionuclides to bioaccumulate in aquatic organisms was then assessed. The life history of several common aquatic organisms was examined to evaluate their use as potential bioindicators of radionuclides released to the Columbia River. Considerations for analyzing strontium (90Sr) in biological sampes were determined. Based on this review of radionuclides released to the environment and their potential for bioaccumulation in aquatic organisms, strontium appears to be the only radionuclide suitable for further study. White sturgeon (Acipenser transmontanus) and the common mussel (Margaritifera margaritifera) are suitable condidates for developing dose reconstruction scenarios. Considerations for tissue analysis of radionuclide concentration in these species include potential for biological turnover and tissue mass. (Author's abstract)
W91-03564

SUPERFUND RECORD OF DECISION: G.E. WIRING, PR.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-03565

SUPERFUND RECORD OF DECISION: NL/TARACORP/GOLDEN AUTO, MN.
For primary bibliographic entry see Field 5G.
W91-03566

SUPERFUND RECORD OF DECISION: BROWN WOOD PRESERVING, FL.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-03567

TYPES AND EFFECTS OF MICROBIAL CONTAMINATION OF GROUNDWATER.
Environmental Protection Agency, Research Triangle Park, NC. Office of Research and Development.
G. F. Craun.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-222699/AS. Price codes: AO3 in paper copy, AO1 in microfiche. Report No. EPA/600/D-89/067. 1989. 32p, 5 fig, 6 tab, 4 ref.

Descriptors: *Groundwater pollution, *Path of pollutants, *Public health, *Water pollution sources, Disinfection, Drinking water, Groundwater quality, Pathogens.

Water may become a vehicle for the transmission of illness as well as a reservoir for the development of organisms that harbor or transmit illness. The incidence of water-related illnesses in the United States and other developed countries is low compared with most of the rest of the world. Nevertheless, there is a residual occurrence of waterborne disease which can and should be eliminated. A significant number of outbreaks and cases of illness occur because of groundwater contamination. Almost half of the waterborne outbreaks and cases of illness reported in the United States during 1971-85 were caused by the use of contaminated, untreated or inadequately treated groundwater. An analysis of 48 waterborne outbreaks and 54,935 cases of illness caused by source and treatment deficiencies in community water systems during 1946-70 showed that the use of untreated groundwater resulted in a high waterborne illness rate, 84.53 illnesses per million people served per year, or about six times the overall waterborne illness rate of all water systems. This indicates that either the quality of groundwater in many cases is questionable, the source is inadequately protected, the well is inadequately developed, or that the proper treatment is not being provided. If the disinfection of all community groundwater supplies were required and practiced, it is anticipated that the waterborne illness rate in groundwater supplies could be lowered to 22.6 illnesses per million people per year. Placing more emphasis on the operation and maintenance of continuous disinfection should result in an even lower rate, comparable to that observed for treated surface water supplies (4.6 illnesses per million people served per year). (Author's abstract)
W91-03577

VULNERABILITY OF KARST AQUIFERS TO CHEMICAL CONTAMINATION.
Environmental Protection Agency, Washington, DC. Office of Health and Environmental Assessment.
M. S. Field.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-218820/AS. Price codes: AO3 in paper copy, AO1 in microfiche. Report No. EPA/600/D-89/008. November 1988. 16p, 1 fig, 28 ref.

Descriptors: *Groundwater movement, *Groundwater pollution, *Groundwater quality, *Karst, *Path of pollutants, *Water pollution sources, Aquifers, Caves, Dolines, Ecological effects, Flood effects, Springs, Water table, Wells.

Groundwater flow in Karst aquifers is very different from flow in granular or fractured aquifers. Karst groundwater flow is often turbulent within discrete conduits that are convergent in the upper reaches and divergent in the lower, simulating the flow pattern of surface water streams that are dendritic or trellised but with discharge to one or more springs. Significant precipitation tends to flood karst aquifers quickly, causing a rapid rise in the water table that may flood higher levels with discharge to different springs. The epikarstic zone stores and directs infiltrating water down discrete percolation points. The vulnerability of karst aquifers to chemical contamination is a result of these characteristics. Chemical contamination may be fed directly to a karst aquifer via overland flow to a doline with little or no attenuation that may contaminate downgradient wells, springs, and dolines within a few hours to a few days. Contaminants may also become temporarily stored in the epikarstic zone for eventual release to the aquifer. Flood pulses may flush the contaminants causing transiently higher levels of contamination in the aquifer and discharge points. The convergent nature of flow in karst aquifers may result in contamination becoming concentrated in conduits. These contaminants can affect delicate plant and animal life that exists in caves as well as contaminate drinking water supplies too rapidly for adequate warning. (Author's abstract)
W91-03578

CHROMIUM DISTRIBUTION AND TRANSPORT BENEATH A CONTAMINATED SITE.
Sandia National Labs., Albuquerque, NM.
C. L. Stein, and D. F. McTigue.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-009696/AS. Price codes: AO4 in paper copy, AO1 in microfiche. February 1989. 50p, 16 fig, 7 tab, 12 ref, append. DOE Contract DE-AC04-76DP00789.

Descriptors: *Chromium, *Groundwater pollution, *Model studies, *New Mexico, *Path of pollutants, *Soil contamination, *Waste dumps, Geology, Pollutant transport.

For an undetermined period of years during the 1970s, liquid waste containing unspecified but significant quantities of chromium was dumped into an unlined disposal pit in surficial alluvium in the Sandia National Laboratories (New Mexico) chemical disposal site in Technical Area III. The alluvial sediments are variable in particle size and contain lenses of gravel and/or cobbles and clay/silt layers. Mineralogy consists of quartz, illite and kaolinite, calcite, gypsum, and feldspar (mainly microcline). Depth to the water table beneath this site is approximately 145 m. A single borehole was

drilled and sampled at the site in 1981. In 1983, previous workers sampled and analyzed soil from four 23-m deep holes drilled along an east-west profile across the pit. Cr was detected at that time to a depth of 15 m beneath the pit, and at a depth between 3 and 8 m at a distance 5.5 m west of the western end of the pit. Cr was detected in samples collected in 1987 at concentrations of about 150 micrograms/g at a depth of 15 m directly below the pit, and about 60 micrograms/g at a depth of 14 m below a point 5.5 m west of the west end of the pit. The 1987 sampling showed Cr to be present at a depth of 23 m in three of the holes. Superposition of the 1983 and 1987 data shows downward migration and dispersion of Cr. A model for Cr transport prior to 1981 was based on assumptions about the dumping history. One-dimensional simulations, in conjunction with a parameter-estimation code, yielded estimates of the average convection velocity (53 nm/s) and dispersivity (3.0 sq nm/s). Subsequent simulations, using the measured 1983 profile as the initial condition and the 1987 profile as a final state, yielded reasonably consistent values for the velocity (30 nm/s) and dispersivity (17 sq nm/s). This exercise illustrates a number of issues likely to be encountered in any attempt to couple site-specific data with even simple model calculations. Significant factors include sampling distribution and methodology; effects of smoothing, interpolation, and extrapolation of data; assumptions regarding boundary conditions where unknown; effects of two-dimensional and three-dimensional transport; sediment inhomogeneity; biological and geochemical transformation effects; and definition of appropriate 'goodness of fit' measures. (Author's abstract)
W91-03579

ADVANCED UTILITY SIMULATION MODEL, ANALYTICAL DOCUMENTATION, STATE LEVEL MODEL (VERSION 1.0).
Illinois Univ. at Urbana-Champaign. Coll. of Engineering.
For primary bibliographic entry see Field 7C.
W91-03581

SUPERFUND RECORD OF DECISION: WILDCAT LANDFILL, DE.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-03587

HEALTH ASSESSMENT FOR ALSCO ANACONDA NATIONAL PRIORITIES LIST (NPL) SITE, GNADENHUTTEN, OHIO.
Agency for Toxic Substances and Disease Registry, Atlanta, GA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-100330. Price codes: A02 in paper copy, A01 in microfiche. January 1989. 9p.

Descriptors: *Alsco Anaconda National Priority Site, *Groundwater pollution, *Ohio, *Path of pollutants, *Pollutant identification, *Soil contamination, *Water pollution sources, Aroclors, Cyanide, Fluorides, Gnadenhutten, Heavy metals, Manganese, Nitrates, Polychlorinated biphenyls, Public health, Selenium.

The Alsco Anaconda plant in Gnadenhutten, Ohio, is listed on the National Priorities List, was sampled for soil, sludge, groundwater, and sediment contamination. On-site soils were found to be contaminated with manganese at levels of public health concern, 480-7,200 parts per million (ppm). Swamp sediments were found to be contaminated with polychlorinated biphenyls (PCBs) (Aroclor 1242, 1248, and 1254) at levels of public health concern, < 0.16-3,000 ppm. Groundwater samples show that cyanide (total) (< 0.02-0.47 ppm), fluoride (< 0.1-8.7 ppm), nitrate (< 0.1-21 ppm), and selenium (< 0.001-0.015 ppm) were all at levels of public health concern. The site is considered to be of potential public health concern because of the risk to human health caused by the possibility of exposure to hazardous substances via the ingestion of contaminated biota found in the swamp, and of river water after the site has been flooded. (Author's abstract)
W91-03593

HEALTH ASSESSMENT FOR WINDOM DUMP, MINNESOTA.
Minnesota Dept. of Health, Minneapolis.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-100322. Price codes: A03 in paper copy, A01 in microfiche. June 1989. 26p, 1 tab, 16 ref, append.

Descriptors: *Groundwater pollution, *Minnesota, *Path of pollutants, *Public health, *Volatile organic compounds, *Waste dumps, Drinking water, Municipal water supply, Wells, Windom Dump Site.

The Windom Dump Site, Windom, Minnesota is listed on the National Priorities List. Thirty-one volatile organic compounds (VOCs) have been detected in groundwater beneath the site and at its perimeter. Eight of these VOCs were detected at concentrations greater than Recommended Allowable Limits (RALs) for drinking water. A Windom city well has also been contaminated. The city well has contained a maximum 2 micro g/L cis-1,2-dichloroethylene (1,2-DCE) and 4 micro g/L vinyl chloride. The RALs for 1,2-DCE and vinyl chloride are 70 micro g/L and 0.15 micro g/L, respectively. 1,2-DCE was detected in the distribution system at a concentration of 1.2 micro g/L; vinyl chloride was not detected. Use of the contaminated city well has continued on a limited basis since the 1,2-DCE detection in the distribution system. Potential for human exposure of public health concern to site contaminants exists if the VOC concentrations in the contaminated city well increase, or if the only city wells become contaminated. However, if frequent monitoring of the Windom city wells is continued, early detection of contaminants and prompt response actions will make substantial exposure to contaminants via the municipal water supply unlikely. (Author's abstract)
W91-03596

HEALTH ASSESSMENT FOR WASTE DISPOSAL ENGINEERING, INC. SANITARY LANDFILL SITE, ANDOVER, MINNESOTA.
Agency for Toxic Substances and Disease Registry, Atlanta, GA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-100306. Price codes: A03 in paper copy, A01 in microfiche. April 1988. 12p, 4 tab, 8 ref.

Descriptors: *Air pollution, *Groundwater pollution, *Minnesota, *Path of pollutants, *Public health, *Sanitary landfills, *Volatile organic compounds, Drinking water, Dusts, Lime sludge, Sediment contamination, Vapors.

Waste Disposal Engineering Inc. Sanitary Landfill, is an NPL site located in the City of Andover. The 173-acre site was used to landfill municipal refuse and industrial wastes. Volatile organic compounds and lime sludge are the predominant contaminants present at the landfill. Exposure pathways for the site are the following: ingestion of surface water, groundwater, sediment, and lime sludge; inhalation of dusts and vapors generated on-site; and dermal exposure to surface water, sediment, lime sludge, groundwater, and exposed water. The remedial action proposed will address major health concerns for the site. There is public health concern regarding inhalation and dermal absorption of lime sludge (particularly to the fugitive dust generated) and vapors, as well as ingestion exposure to the lime sludge. (Author's abstract)
W91-03597

SUPERFUND RECORD OF DECISION: CROYDEN TCE SPILL, PA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-03601

CYCLE IN THE SYSTEM SOIL-PLANT-ANIMAL ON LOCATIONS WITH EXTREMELY HIGH SOIL CONTAMINATION BY CADMIUM AND NICKEL CAUSED BY SEWAGE-SLUDGE (KREISLAUF IM SYSTEM BODEN-PFLANZE-NUTZTIER AUF STANDORTEN MIT EXTREM HOHER CADMIUM-UND NICKELBELASTUNG DURCH KLARSCHLAM-MAUFBRINGUNG).
Landwirtschaftliche Untersuchungs- und Forschungsanstalt, Speyer (Germany, F.R.).
G. Crossmann.
Available from the National Technical Information Service, Springfield, VA 22161 as TIB/B88-82380. Price codes: E11 in paper copy, X00 in microfiche. Report No. UBA-FB 86-106, December 1986. 95p, 3 fig, 52 tab, 47 ref. English summary.

Descriptors: *Bioaccumulation, *Cadmium, *Crops, *Heavy metals, *Nickel, *Soil contamination, Food chains, Leaching, Nitrates, Soil properties, Vegetable crops.

In 3-year field experiments the uptake and accumulation of cadmium and nickel in vegetable and arable plants was studied. The soils were characterized by high sorption conditions (clay, organic matter, pH, Fe-oxides and Mn-oxides). The availability of Cd and Ni therefore was relatively low. The aqua regia soluble contents were on the average 157 mg Cd and 558 mg Ni/kg soil, with large variations. The high nitrate concentrations over all the years were remarkable. The Cd-content in vegetables decreased in the following order: leaves-roots-kale-onion-fruits-potatoes-legumes. A low Cd-content was also found in grains of barley and maize. Leafy-vegetables and legumes showed higher Ni-contents than other vegetables. Limits and practicalities of plant cultivation on highly contaminated soils were discussed in regard to contaminant transfer into plants and leaching. The large nitrogen supply and its mobility needs permanent plant cultivation (e.g. industrial plants, plantations). The degradation of sorptive soil conditions increases the risk of higher Cd-availability and Ni-availability and leaching processes, with unfavorable effects on food chains and on the ecosystem. (Author's abstract)
W91-03602

GROUND WATER POLLUTION TRANSPORT: MODEL STUDIES (JAN 75-MAR 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 10C.
W91-03604

UPWARD MIGRATION OF UNDERGROUND INJECTION WASTES THROUGH HYDROLOGIC CONDUITS AROUND THE WELLBORE.
Argonne National Lab., IL. Energy and Environmental Systems Div.
For primary bibliographic entry see Field 5E.
W91-03606

ROLE OF CROPPING SYSTEMS IN ENVIRONMENTAL QUALITY: GROUNDWATER NITROGEN.
Agricultural Research Service, Lincoln, NE.
For primary bibliographic entry see Field 3F.
W91-03643

NUTRIENT LOADING STATUS OF THE CONESTOGA RIVER BASIN, 1985-1989.
Susquehanna River Basin Commission, Harrisburg, PA. Resource Quality Management and Protection Div.
A. N. Ott.
Susquehanna River Basin Commission, Harrisburg, PA. Publication No. 133, September 1990. 11p, 4 fig, 3 tab.

Descriptors: *Conestoga River, *Nonpoint pollution sources, *Nutrient concentrations, *Water pollution sources, *Water quality, Monitoring, Nitrates, Nitrogen, Phosphorus, Pollution load, Wastewater treatment.

The Conestoga River at Conestoga, PA, is one of 14 sites that has been monitored for its nutrient

content during a five year period from 1985-1989. A primary purpose of this monitoring program is to establish a sound database which can be used to plan, implement, and evaluate immediate and long-range reduction efforts. The Conestoga River data presents a prime example of how this information can be used. Nutrient monitoring of the Conestoga River has indicated no change in the nitrogen loading for the period 11985-1989, but shows a slight decrease in the phosphorus load for 1988 and a significant decrease for 1989. Records from the Lancaster sewage treatment plant (STP) show a decreased phosphorus concentration in their effluent midway through 1988 and an even lower concentration throughout 1989. While they have significantly decreased their ammonia concentration during the same period, the nitrate concentration has concurrently increased. Subtraction of the point source STP nutrient load from the measured basin load provides an estimate of the nonpoint source nutrient load. Evaluation of this phosphorus load with water discharge shows no change in loading from 1985-1988, but shows a definite load decrease in 1989. This decrease in 1989 phosphorus nonpoint source load is shown to be coincidental with the lower than normal suspended sediment load in 1989. This report indicates that long-term monitoring data can be used to detect changes in small tributary watersheds. However, interpretation of the data must be coupled with a knowledge of the changing conditions within the watershed. (Lantz-PTT)
W91-03647

INTRODUCTION TO MODELING OF TRANSPORT PHENOMENA IN POROUS MEDIA.
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-03654

PROCEEDINGS OF THE SIXTH CORPS CHEMISTS MEETING, 16-17 MAY 1989.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5A.
W91-03659

MANAGEMENT OF LAKE ONTARIO RESOURCES: A HOLISTIC PERSPECTIVE.
State Univ. of New York at Buffalo.
For primary bibliographic entry see Field 2H.
W91-03678

ASSESSMENT OF AGRICULTURAL NONPOINT SOURCE POLLUTION POTENTIALS IN THE CANADIAN GREAT LAKES BASIN.
Guelph Univ. (Ontario). Dept. of Land Resource Science.
G. J. Wall, E. A. Pringle, and W. T. Dickinson.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 179-188, 1 fig, 3 tab, 19 ref.

Descriptors: *Fertilizers, *Great Lakes, *Nonpoint pollution sources, *Path of pollutants, *Pesticides, *Triazine herbicides, *Water pollution sources, Agricultural chemicals, Alachlor, Atrazine, Cadmium, Farm wastes, Lake management, Land management, Phosphorus, Pollution load, Surface-groundwater relations, Water quality management, Water quality standards, Water resources management.

Existing agricultural land data bases plus stream water and sediment quality in intensively farmed areas of the Canadian Great Lakes basin (Ontario) were examined to assess the magnitude and potential sources of agricultural nonpoint pollution. The analysis revealed high fertilizer and pesticide use with phosphorus applications occurring at up to three times the recommended rate in some regions. Soil hydrologic conditions in the study area indicated high potential to transfer pollutants to surface water and groundwater. Soil and water conservation practices have been used minimally. The combination of fertilizer and pesticide use along with soil potentials for pollutant transfer indicated that Kent and Elgin counties possessed the highest relative potentials within the study area to contribute to agricultural nonpoint source pollution. Tributary water quality data indicated the presence of all 8 contaminants analyzed (PCBs, HCBs, OCS, P, Cd, Cl, Pb, and NO3). Phosphorus and cadmium consistently exceeded water quality standards in all tributaries, and agricultural pesticides such as atrazine and alachlor were found in 93% and 15% of all Thames River samples respectively. Several computational methods were used to calculate annual loading rates for P, Cd, Cl, NO3, Pb, atrazine, alachlor, metolachlor, and cyanazine for some of the tributaries. High tributary pollutant concentrations and the resulting loads in the predominantly agricultural nonpoint source pollution has been contributing to impaired water quality in the study area. Comprehensive land management must be promoted at the farm level, and water quality monitoring and standards must be improved. (See also W91-03672) (Author's abstract)
W91-03692

NIAGARA'S PROGRAM FOR REDUCTION OF PRIORITY POLLUTANTS TO THE NIAGARA RIVER.
Niagara Regional Municipality, Thorold (Ontario).
C. H. Eidt.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 189-200, 2 fig.

Descriptors: *Great Lakes, *Lake management, *Niagara River, *Priority pollutants, *Water pollution control, *Water quality management, *Water resources management, Canada, Pollution load, Sewer systems, Wastewater disposal, Wastewater facilities, Wastewater treatment, Water pollution sources.

The Niagara River Toxics Committee Report of October 1984 identified eight significant discharges of priority and special pollutants reaching the Niagara River from the Canadian side; four from industrial sources and four from municipal sources. Three are water pollution control plants operated by Niagara and the fourth, a combined sewer in Welland. The Niagara Falls 12 MIGD primary plant was given highest priority. A process study was initiated including a pilot plant to determine methods of handling normal flow plus loading from canning and winery industries. The recommended solution was installation of rotating biological contactors. Operating problems were encountered, resolved, and pollutant discharges significantly reduced. Similar studies were carried out for Anger Avenue 5.4 MIGD pollution control plant in Fort Erie and Welland 10.0 MIGD pollution control plant in Welland, which discharges indirectly into the Niagara River. In both cases, studies recommended continuation of activated air process with two lines of sewage treatment, one for normal sewage and a second for weak sewage during wet weather periods. Both plants are under construction and the Welland plant includes sand filtration to reduce ammonia. The fourth source, a combined sewer, will be connected to the Welland plant and treated. (See also W91-03672) (Author's abstract)
W91-03693

PHOSPHORUS LEVELS IN ONTARIO STREAMS TRIBUTARY TO THE GREAT LAKES A DECADE AFTER PLUARG.
Ontario Ministry of the Environment, Toronto.
B. Bodo.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 211-220, 4 fig, 1 tab, 14 ref.

Descriptors: *Great Lakes, *Phosphorus, *Water pollution control, *Water quality management, *Water quality standards, Agricultural runoff, Eutrophication, Farm wastes, Lake Erie, Lake Ontario, Lake management, Land use, Ontario, Water quality trends, Water resources management.

Broad scale spatial analysis of recent total phosphorus (P) levels in 116 Ontario streams tributary to the Great Lakes reveals that in the majority of tributaries across southern Ontario P exceeds a criterion of 30 micrograms/L intended for protection against in-stream eutrophication. Tributary P inputs remain of concern, particularly to Lake Erie where levels at all sites exceed 30 micrograms/L and at 16 of 21 sites exceed 90 micrograms/L; and to a lesser degree, Lake Ontario where a majority of 45 streams exceeds the 30 micrograms/L criterion. With the exception of Lake Huron, drainage from Ontario's agricultural southwest, upper lakes tributaries generally exhibit low P. Trend screening of recent (1985-87) records against 1975-77 Pollution from Land Use Activities Reference Group (PLUARG) era records at 109 sites shows significant P declines in Lake Ontario tributaries, but little net change elsewhere. Continuing surveillance is warranted on the lower lakes tributaries as both urban and agricultural land uses continue to intensify. Past and future changes in measurement protocols must be documented to assure reliable interpretation of long-term trends. (See also W91-03672) (Author's abstract)
W91-03695

WATER QUALITY IN A THIN WATER-TABLE AQUIFER ADJACENT TO LAKE MICHIGAN, WITHIN A HIGHLY INDUSTRIALIZED REGION OF INDIANA.
Geological Survey, Indianapolis, IN.
K. J. Banaszak, and J. M. Fenelon.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 247-258, 2 fig, 5 tab, 8 ref.

Descriptors: *Great Lakes, *Groundwater pollution, *Hazardous wastes, *Water pollution sources, Alkalinity, Calumet aquifer, Groundwater quality, Hydrogen ion concentration, Lake Michigan, Lake management, Oil industry, Specific conductivity, Steel industry, Unconfined aquifers, Water quality management, Water resources management, Water temperature.

Many sources of hazardous material directly overlie the thin, water-table, low-hydraulic-gradient Calumet aquifer, whose water ultimately reaches Lake Michigan. Thirty-five stainless steel wells, including six pairs of nested wells, were sampled in a 50-square-mile area. Field characteristics measured were temperature, pH, specific conductance, dissolved oxygen, and alkalinity. Additional analytes were three nutrients; three common anions; bromide; boron; silica; four common cations; 11 heavy metals; and 88 organic chemicals, including some organic chemical groups, such as phenol. Median pH was 7.3, but samples from three wells screened in slag had pH values above 11. Median alkalinity was 290 mg/L as CaCO3, but concentrations in three samples exceeded 900 mg/L. Median specific conductance was 1,200 microseimens/cm, but six values exceeded 2,380 microseimens/cm. Of these six samples, three were from fresh slag and the other three were contaminated by petroleum products. Sixty-seven of the organic chemicals analyzed, including trichloroethylene, were not detected. Phenol, however, was found in samples collected from wells in or near steel or petrochemical plants were significantly different (at the 95% confidence level) from medians in samples from all other wells. (See also W91-03672) (Author's abstract)
W91-03699

NONPOINT POLLUTION: 1988-POLICY, ECONOMY, MANAGEMENT, AND APPROPRIATE TECHNOLOGY.
For primary bibliographic entry see Field 5G.
W91-03704

EFFECTS ON U.S. WATER RESOURCES OF AGRICULTURAL CHEMICALS AND RUNOFF: MAGNITUDE, EXTENT, AND ECONOMIC CONSEQUENCES.
Economic Research Service, Washington, DC.
For primary bibliographic entry see Field 6G.
W91-03709

RESULTS OF FIFTEEN YEARS OF CONTINUOUS MONITORING OF WATER QUALITY IN THE RUHR RIVER HEAVILY AFFECTED BY RESIDUAL POINT AND NONPOINT POLLUTION.
Ruhrverband, Essen (Germany, F.R.).
D. R. Albrecht.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 271-281, 14 fig, 10 ref.

Descriptors: *Aeration, *Germany, *Monitoring, *Nonpoint pollution sources, *Ruhr River, *Stream pollution, *Water pollution control, *Water pollution sources, Algal growth, Dissolved oxygen, Eutrophication, Instream aeration, Runoff, Storm water management, Urban runoff, Wastewater management, Wastewater treatment, Water quality trends, Water resources management.

A large fish kill in the impoundment Lake Baldeney on the Ruhr River in 1963 was an incentive to create a system for instream aeration in the lower Ruhr River. The river presently receives treated secondary sewage and urban and rural runoff from heavily populated areas of Germany. Industrial wastewater contribution in the Ruhr basin amounts to 47% of the total wastewater flow. Instream aeration has been used for mitigation of the remaining pollution and problems of eutrophication. Operation of the aeration devices requires continuous dissolved oxygen (DO) monitoring at selected key cross-sections of the river. Statistical evaluation of the results provides detailed information on water quality and eutrophication trends of the river. The results showed that in the period from 1972 to 1987 the winter averages of dissolved oxygen in the river were increased form 62 to 95% of saturation. During summer half-years frequently oversaturation due to algal photosynthesis occurs. It has been found that secondary pollution due to algal productivity is becoming a major factor in the DO-regime. As phosphorus concentrations have been diminished in the Ruhr after 1976, mass algal developments are now reduced. New targets for the Ruhr water quality and recent legal requirements demand further reduction of phosphorus and ammonia in wastewater treatment plants. Future strategies are further focused on the reduction of organic halogens which can be adsorbed by activated carbon and on nonpoint pollution abatement by improved storm water treatment in combined sewage systems. (See also W91-03704) (Author's abstract)
W91-03733

MODELING NONPOINT POLLUTION AT THE WATERSHED LEVEL WITH THE AID OF A GEOGRAPHIC INFORMATION SYSTEM.
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
For primary bibliographic entry see Field 4D.
W91-03734

IRRIGATION-INDUCED WATER QUALITY PROBLEMS: POLICY IMPLICATIONS OF DOI RECONNAISSANCE STUDY RESULTS.
National Irrigation Water Quality Program, Washington, DC.
J. P. Deason.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 293-302, 4 tab, 9 ref.

Descriptors: *Environmental policy, *Irrigation effects, *Nonpoint pollution sources, *Surveys, *Water pollution sources, *Water quality, *Water resources management, Climatic effects, DDE, Drainage effects, Environmental impact, Geologic control, Irrigation water, Pesticides, Selenium, Trace elements, Water policy, Water pollution control, Watersheds, Wetlands.

In 1986, the U.S. Department of the Interior embarked on a series of reconnaissance level investigations throughout the western states to identify and assess potential irrigation-induced water quality problems. A series of water, sediment, and biological samples are being analyzed for selenium and 16 other trace elements, as well as a number of pesticides. Nine investigations in seven states have been completed and ten additional investigations are underway. A number of generic observations can be made, based upon the results of the first nine investigations: (1) knowledge of geologic sources of trace elements is very important in determining where problems with irrigation-induced contamination are likely to exist; (2) meteorological characteristics of an area can be very meaningful regarding potential for problems; (3) closed watersheds were found to be an important physical characteristic of locations that may tend to exhibit symptoms of irrigation-induced contamination; (4) at the study areas where selenium was found to be at levels that could adversely affect wildlife reproduction and growth, extensive irrigation and drainage activities occur; (5) selenium is the constituent of concern commonly found at elevated concentrations in wetland ecological systems receiving irrigation drainage water; (6) concentrations of analytes were found to vary widely on a spatial basis in all media sampled; (7) yearly variations in precipitation and streamflow make accurate assessments of conditions in a given area difficult without a long period of analysis; and (8) organochlorine pesticides (principally DDE) generally were detected only in areas where applications have been large, and concentrations were low in water, sediment, and biota. (See also W91-03704) (Fish-PTT)
W91-03735

DIFFUSED GROUNDWATER CONTAMINATION BY HERBICIDES IN AN AGRICULTURAL AREA IN NORTHERN ITALY.
Marquette Univ., Milwaukee, WI. Dept. of Civil Engineering.
A. G. Capodaglio, M. Baldi, P. Valentini, and G. Bellinzona.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 303-312, 2 fig 5 tab, 8 ref.

Descriptors: *Agricultural chemicals, *Groundwater pollution, *Herbicides, *Italy, *Nonpoint pollution sources, *Water pollution control, *Water pollution sources, *Water resources management, Atrazine, Drinking water, Environmental impact, Molinate, Po River, Public health, Regulations, Social aspects, Water policy, Water quality standards.

Residues of herbicides were detected in 1986 in public and private water supply wells throughout the Po River Valley in northern Italy. Atrazine and molinate were the two compounds most frequently identified. Although the concentrations of herbicides were relatively low compared to U.S. standards, their occurrence was considered an index of environmental stress in the area, thus raising concern in scientists and the general public. Moreover, drinking water standards derived from the European Community's directives set the allowable limits for the detected compounds below their actual concentrations in aquifers, causing an emergency-type situation for the population relying on the 'contaminated' aquifer for their water supply. The contamination of groundwater detected in the study area does not have immediate adverse health effects for the resident population, although long-term consequences of human exposure to the herbicides found have not yet been thoroughly studied. The emotional response of the public to the occurrence is exacerbated by the contradictions and continuous changes in the regulations which also promote lack of credibility in the official organizations entrusted with the safeguard of public health. The long-term monitoring of the aquifer underlying agricultural areas which are the source of the contamination is expected to give useful information on the spread of the contamination and on the natural processes occurring within the soil in the affected areas, regardless of the magnitude of the real hazards at the present time, and may be usefully employed to promote more environmentally sound cultivation practices, as well as to guide the implementation of fair regulatory measures. (See also W91-03704) (Fish-PTT)
W91-03736

TRANSPORT IN HETEROGENEOUS POROUS FORMATIONS: 1. TIME-DEPENDENT CONVECTIVE DISPERSION.
Centre National de la Recherche Scientifique, Toulouse (France). Inst. de Mecanique des Fluides.
For primary bibliographic entry see Field 7C.
W91-03755

TRANSPORT IN HETEROGENEOUS POROUS FORMATIONS: 2. TIME-DEPENDENT DOUBLE DISPERSION.
Centre National de la Recherche Scientifique, Toulouse (France). Inst. de Mecanique des Fluides.
For primary bibliographic entry see Field 7C.
W91-03756

ESTIMATION OF DIFFUSE INPUTS TO A COASTAL SEA: SOLUTION TO AN INVERSE MODELLING PROBLEM.
Institut Rudjer Boskovic, Zagreb (Yugoslavia).
For primary bibliographic entry see Field 2L.
W91-03817

TRACE METAL CHEMISTRY OF A DUTCH RESERVOIR, THE TJEUKEMEER.
Limnologisch Inst., Oosterzee (Netherlands). Tjeukemeer Lab.
For primary bibliographic entry see Field 2H.
W91-03827

FACTORS AFFECTING SULFUR INCORPORATION INTO LAKE SEDIMENTS: PALEOECOLOGICAL IMPLICATIONS.
State Univ. of New York at Syracuse. Coll. of Environmental Science and Forestry.
For primary bibliographic entry see Field 2H.
W91-03828

STABLE ISOTOPIC COMPOSITIONS OF SULFUR IN PIRLA SEDIMENT CORES.
Marine Biological Lab., Woods Hole, MA. Ecosystems Center.
For primary bibliographic entry see Field 2H.
W91-03829

PALAEOECOLOGICAL TEST OF THE LAND-USE HYPOTHESIS FOR RECENT LAKE ACIDIFICATION IN SOUTH-WEST NORWAY USING HILL-TOP LAKES.
Bergen Univ. (Norway). Botanical Inst.
For primary bibliographic entry see Field 2H.
W91-03830

REVIEW OF IMMISCIBLE FLUIDS IN THE SUBSURFACE: PROPERTIES, MODELS, CHARACTERIZATION AND REMEDIATION.
GeoTrans, Inc., Herndon, VA.
J. W. Mercer, and R. M. Cohen.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 2, p 107-163, September 1990. 5 fig, 5 tab, 236 ref, 2 append.

Descriptors: *Cleanup, *Groundwater pollution, *Hydrocarbons, *Literature review, *Path of pollutants, *Remediation, *Site remediation, *Water pollution treatment, Chemical properties, Groundwater transport, Mass transfer, Solubility, Solute transport, Vadose zone, Vaporization.

Nonaqueous phase liquids (NAPLs) are immiscible fluids that result from a variety of industrial processes and are found at numerous contaminated sites. NAPLs behave differently than dissolved solutes in the subsurface. Their behavior depends on fluid properties such as interfacial tension, viscosity and density. Density determines if the immiscible fluid is lighter than water (LNAPL) or heavier than water (DNAPL). In addition, mass transfer produces vapor transport in the vadose

zone and solute transport in groundwater. Mass transfer depends on properties associated with volatilization and aqueous solubility. LNAPLs are often associated with petroleum hydrocarbons. Because of work performed in the petroleum industry, considerable information has been developed on properties associated with petroleum products. In addition, because LNAPL is at or near the water table, characterization and remediation are generally more successful than at DNAPL sites. Remediation of NAPL contamination often involves a combination of techniques to form a treatment train. Mobile NAPL should be recovered using a pump-and-treat technology. This will leave behind a residual saturation that might be remediated by another technique such as vacuum extraction or EOR methods. Residual NAPL recovery, especially for DNAPL, is difficult with no routine proven technology available. At some sites, hydraulic containment may be the only practical contaminant management option. Considerable research is necessary before NAPL problems are well understood. (Hoskin-PTT)
W91-03847

SORPTION AND DEGRADATION OF CHLOROPHENOLS, NITROPHENOLS AND ORGANOPHOSPHORUS PESTICIDES IN THE SUBSOIL UNDER LANDFILLS--LABORATORY STUDIES.
Technical Univ. of Denmark, Lyngby. Dept. of Sanitary Engineering.
P. Kjeldsen, J. Kjolholt, B. Schultz, T. H. Christensen, and J. C. Tjell.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 2, p 165-184, September 1990. 6 fig, 7 tab, 21 ref.

Descriptors: *Chemical degradation, *Landfills, *Nitrophenols, *Organophosphorus pesticides, *Path of pollutants, *Pesticides, *Sorption, Anaerobic conditions, Denmark, Dimethoate, Fate of pollutants, Groundwater movement, Groundwater pollution, Leachates, Malathion, Phenols, Sand, Soil columns, Sulfotep.

To study the fate of co-disposed chemicals in the subsoil of landfills, anaerobic soil columns loaded with anaerobic leachate from a municipal landfill were set up. The leachate was spiked with eleven compounds representing three groups of chemicals: chlorophenols, nitrophenols and organophosphates. Two subsoils, a coarse sand and a sandy loam, were used in the study. The columns were maintained at Danish groundwater temperature (8-10 degrees) and were run for a period of 10 months. Analysis of the influent leachate concentrations of the spiked compounds showed that the concentrations were constant during the entire experimental period. Many of the compounds showed delayed breakthrough (compared to chloride breakthrough) in both soils, followed by a constant effluent concentration ratio of less than unity indicating that degradation was occurring. The velocities for the chlorophenols and nitrophenols were in the range of 10-100% of the water velocity in the two subsoils. The distribution coefficient for the specific phenol, the acidity and the pH of the soil apparently governed the retardation of the phenolic compounds. Degradation of most of the phenols was observed with half-life values of 30-150 days. The four organophosphorus pesticides, Dimethoate, Malathion, Sulfotep and Fenitrothion, showed relative velocities from <10% to ca. 100%. Malathion and Sulfotep were degraded with half-life values of 10-20 days, while Dimethoate was not significantly degraded in the two soil columns. Fenitrothion did not appear in the effluent from the columns, probably due to high retardation. (Author's abstract)
W91-03848

SEPARATION OF RADIONUCLIDE MIGRATION BY SOLUTION AND PARTICLE TRANSPORT IN SOIL.
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
J. Torok, L. P. Buckley, and B. I. L. Woods.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 2, p 185-203, September 1990. 11 fig, 3 tab, 12 ref, append.

Descriptors: *Groundwater pollution, *Ion transport, *Path of pollutants, *Radioisotopes, *Solute transport, Adsorption, Cesium radioisotopes, Cobalt radioisotopes, Colloids, Diffusion coefficient, Laboratory methods, Lysimeters.

Laboratory-scale lysimeter experiments were performed with simulated waste forms placed in candidate buffer materials which have been chosen for a low-level radioactive waste repository. Radionuclide releases into the effluent water and capture by the buffer material were determined. The results could not be explained by traditional solute transport mechanisms, and particle transport was suspected as the dominant mechanism for radionuclide release from the lysimeters. To elucidate the relative contribution of particle and solute transport, lysimeter wastes were replaced by a wafer of neutron-activated buffer soaked with selected soluble isotopes. Particle transport was determined by the movement of gamma-emitting neutron-activation products. Solute transport was quantified by comparing the migration of soluble radionuclides relative to the transport of neutron-activation products. Distribution coefficients and rate constants of radionuclide desorption were calculated directly from buffer cores, and rate constants for radionuclide adsorption were then approximated. The results of this experiment and modelling of the solution transport process were used to determine the radionuclide transport mechanism in experiments with simulated waste forms in the lysimeters. The mechanisms are as follows: 137Cs particle transport; 60Co was incorporated as particles within the waste form and released as colloids. The new approach presented here for monitoring radionuclide migration in soil facilitates the determination of most of the fundamental coefficients required to model the transport process. (Author's abstract)
W91-03849

FATE OF NITROGEN AND PHOSPHORUS ENTERING A GULF COAST FRESHWATER LAKE: A CASE STUDY.
Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.
R. D. DeLaune, C. W. Lindau, R. S. Knox, and C. J. Smith.
Water Resources Bulletin WARBAQ, Vol. 26, No. 4, p 621-631, August 1990. 9 fig, 3 tab, 41 ref. NSF Grant BSR8414006.

Descriptors: *Eutrophication, *Fate of pollutants, *Limnology, *Nonpoint pollution sources, *Nutrients, *Path of pollutants, *Phosphorus, *Water pollution sources, Adsorption, Ammonium, Case studies, Cycling nutrients, Denitrification, Lake Verret, Lake sediments, Louisiana, Nitrates, Nitrification, Nitrogen, Nutrient concentrations, Nutrient removal, Orthophosphates, Sedimentation, Water chemistry.

Nitrogen and P fluxes, transformations and water quality functions of Lake Verret (a coastal Louisiana freshwater lake), were quantified. Ortho-P, total-P, NH4(+)-N, NO3-N and Total Kjeldahl nitrogen (TKN) in surface water collected from streams feeding Lake Verret averaged 104, 340, 59, 185 and 1060 mg/L, respectively. Lake Verret surface water concentrations of ortho-P, total-P, NH4+-N, NO3-N and TKN averaged 66, 191, 36, 66 and 1292 micrograms/L. The higher N and P concentrations were located in areas of the lake receiving drainage. Nitrification and denitrification processes were significant in removing appreciable inorganic N from the system. In situ denitrification rates determined from acetylene inhibition techniques show the lake removes 560 mg N/sq m/yr. Laboratory investigations using sediment receiving 450 micrograms NH4(+)-N (15-N labeled) showed that the lake has the potential to remove up to 12.8 g N/sq m/yr. Equilibrium studies of P exchanges between the sediment and water column established the potential or adsorption capacity of bottom sediment in removing P from the overlying water. Lake Verret sediment was found to adsorb P from the water column at concentrations above 50 micrograms P/L and the adsorption rates were as great as 300 micrograms P/sq cm/day. Using the 137Cs dating techniques, approximately 18 g N/sq m/yr and 1.2 g P/sq m/yr were removed from the system via sedimentation. Presently elevated nutrient levels are found only in the upper reaches of the lake receiving nutrient input from runoff from streams draining adjacent agricultural areas. Nitrification, denitrification and adsorption processes at the sediment-water interface over a relatively short distance reduces the N and P levels in the water column. However, if the lake receives additional nutrient loading, elevated levels will likely cover a larger portion of the lake, further reducing water quality in the lake. (Author's abstract)
W91-03857

OPTIMAL BATHYMETRY OF TYRRHENIAN SEA BY STOCHASTIC INTERPOLATORS.
Padua Univ. (Italy). Dipt. di Metodi e Modelli Matematici per le Scienze Applicate.
G. Gambolati, and G. Galeati.
Water Resources Bulletin WARBAQ, Vol. 26, No. 4, p 677-685, August 1990. 6 fig, 3 tab, 25 ref.

Descriptors: *Bathymetry, *Data analysis, *Data interpretation, *Geomorphology, *Mathematical analysis, *Mediterranean Sea, *Path of pollutants, *Stochastic models, *Thermal pollution, Italy, Kriging, Marine environment, Mathematical equations.

The analysis of the sea depth in the vicinity of a thermal power plant is important in view of the heat dispersion and transport of the cooling water discharged from the energy production processes. The bathymetry of the Tyrrhenian Sea in the area facing the thermoelectric plant being built at Montalto di Castro, Italy, is reconstructed with the aid of the kriging technique. The large number of measurements (2038) precludes the use of a global interpolation model. At the same time, the steepness of the variogram suggests that the stochastic process is likely non-stationary. The latter problem is managed by detrending the observed records with a fourth-order polynomial drift determined with the least squares method. The global approach is replaced with local models with an influence radius of 70 m and a minimal number of interpolation records equal to 10. The detrended residuals appear to be second-order stationary having an isotropic variogram that is fitted equally well by a linear or a spherical function. The average size of the local interpolation models is 28, which ensures a high computational efficiency. The bathymetry of the sea area of interest is then reconstructed over a regular grid with a total of 3570 nodes. The estimation standard deviation maps show that the accuracy of the prediction is even greater than the prescribed tolerance (= 0.2 m) and indicate that future data collection campaigns require a less dense and therefore, less expensive recording network. The redundant measurement profiles are identified. Their elimination still allows for bathymetry estimates affected by interpolation errors that fall within the project specifications. (Author's abstract)
W91-03862

MOVEMENT OF CRUDE OIL IN AN EXPERIMENTAL SPILL ON THE SEEDS SIMULATED PIPELINE RIGHT-OF-WAY, FORT NORMAN, N.W.T.
Alberta Univ., Edmonton. Dept. of Geography.
G. P. Kershaw.
Arctic ATICAB, Vol. 43, No. 2, p 176-183, June 1990. 5 fig, 2 tab, 21 ref.

Descriptors: *Northwest Territories, *Oil spills, *Path of pollutants, *Permafrost, *Pipelines, *Simulation analysis, *Subarctic zone, Absorption, Canada, Oil pollution, Soil contamination, Vegetation.

The Studies of the Environmental Effects of Disturbances in the Subarctic (SEEDS) experimental spill was conducted on a simulated pipeline right-of-way and trench. A total of 3273 L of Norman Wells crude oil was released over a 24 h period at a depth of 100 cm in a simulation of a rupture from a subsurface pipeline. Absorptive qualities of the surface vegetation and organic soil layers in an undisturbed forest, produce rates of flow and area

of contamination values much lower than the SEEDS experiment. Similarities exist between the SEEDS spill and previously conducted surface, point-origin, experimental crude oil spills. The areal extent of the oil was controlled by: (1) low volume but continually flowing water in a shallow channel; (2) topographically depressed areas and their degree of interconnectedness; and (3) low absorptive ability of the surfaces in contact with the oil (including moisture content of the substrate). The SEEDS crude oil spill deviated from the other experimental spills in that: (1) the oil front moved rapidly over saturated mineral soil-dominated surfaces, conditions expected over a buried pipeline; (2) average concentration values were low, while area-to-volume ratios were high; and (3) the areal extent of the spill continued to increase until some time after freeze-up, but certainly much longer time periods were required to achieve stability compared with forest area spills. (Lantz-PTT)
W91-03866

BACTERIAL CONTAMINATION AND REMEDIATION MEASURES AT MARINA DEL REY, CALIFORNIA, U.S.A.
Los Angeles County Dept. of Beaches and Harbors, CA.
L. Charness, and D. G. Smith.
Environmental Auditor ENVAE8, Vol. 2, No. 1, p 35-40, 1990. 2 fig, 1 tab, 5 ref.

Descriptors: *Bacteria, *Beach contamination, *Marina del Rey, *Site remediation, *Water pollution prevention, *Water pollution sources, California, Fecal coliforms, Monitoring, Water birds, Water quality control.

Bacterial contamination of the swim beach at Marina del Rey, California, was identified in October 1987 and the area closed to swimmers. Weekly water sampling continued to reveal unacceptable levels of total and fecal coliform and enterococcus bacteria. An environmental audit of potential sources of the high bacterial levels identified shorebird defecation as the most probable cause. Following the installation of overhead monofilament fishing lines, shorebird populations generally abandoned the site, bacterial counts declined significantly, and the beach was reopened in February 1989. Today, bacterial counts remain low. (Author's abstract)
W91-03872

BINATIONAL MANAGEMENT OF HAZARDOUS WASTE: THE MAQUILADORA INDUSTRY AT THE US-MEXICO BORDER.
California Univ., Los Angeles. School of Public Health.
For primary bibliographic entry see Field 5G.
W91-03875

QUANTIFICATION OF HYDROCHLORIC ACID AND PARTICULATE DEPOSITION RESULTING FROM SPACE SHUTTLE LAUNCHES AT JOHN F. KENNEDY SPACE CENTER, FLORIDA, USA.
Bionetics Corp., Cocoa Beach, FL.
T. W. Dreschel, and C. R. Hall.
Environmental Management EMNGDC, Vol. 14, No. 4, p 501-507, 1990. 8 fig, 2 tab, 19 ref. NASA Contract No. NAS10-10285.

Descriptors: *Environmental effects, *Hydrochloric acid, *Kennedy Space Center, *Particulate matter, *Rocket launches, *Space shuttle, *Water pollution sources, Aluminum oxide, Ecological effects, Fishkill, Hydrogen ion concentration, Path of pollutants, Water pollution effects, Wet deposition.

Observations of damage to vegetation, acute reductions in surface water pH, and kills of small fish prompted the Biomedical Operations and Research Office at the JFK Space Center to initiate intensive environmental evaluations of possible acute and long-term chronic impacts that may be produced by repeated launches of the space shuttle. An important step in this evaluation was the identification of deposition patterns and the quantification of ecosystem loading rates of exhaust constituents from the solid rocket motors (SRMs) in the area of the launch pad. These constituents are primarily aluminum oxide (Al2O3) and hydrochloric acid (HCl). During three launches of the space transportation system (STS-11, 13, 14) up to 100 bulk deposition collectors, 83 mm in diameter containing 100 ml of deionized water, were employed in a grid pattern covering 12.6 ha north of launch pad 39-A. Estimates of HCl and particulate deposition levels were made based on laboratory measurements of items entrained in the collectors. Captured particles consisted of a variety of items including Al2O3, sand grains, sea shell fragments, paint chips and other debris ablated from the launch pad surface by the initial thrust of the SRMs. Estimated ranges of HCl and particulate deposition in the study area were 0-127 g/sq m and 0-246 g/sq m. Deposition patterns were highly influenced by wind speed and direction. These measurements indicate that, under certain meteorological conditions, up to 7,100 kg of particulates and 3,400 kg of HCl can be deposited to the near-field environment beyond the launch pad perimeter fence. (Author's abstract)
W91-03878

USE OF FIELD-FLOW FRACTIONATION TO STUDY POLLUTANT-COLLOID INTERACTIONS.
Monash Univ., Clayton (Australia). Water Studies Centre.
R. Beckett, D. M. Hotchin, and B. T. Hart.
Journal of Chromatography JOCRAM, Vol. 517, p 435-447, September 26, 1990. 3 fig, 37 ref.

Descriptors: *Adsorption, *Analytical techniques, *Data acquisition, *Fate of pollutants, *Path of pollutants, Analytical methods, Atrazine, Australia, Chemical interactions, Colloids, Fluid-flow fractionation, Glyphosate, Orthophosphate pesticides, Particle size, Particulate matter, Radioactive tracers, River sediments, Sediments, Soils.

The association of pollutants and other trace elements and compounds with particle surfaces plays a dominant role in determining their transport, fate, biogeochemistry, bioavailability, and toxicity in natural waters, sediments, and soils. The adsorption of pollutants to sediments depends on the specific surface area and the nature of the particle surfaces. It is believed that the ubiquitous coatings of Fe and Mn oxides and organic matter, which is invariably present on the surface of natural particles, may well be the dominant factor in determining the surface adsorption density. A new approach has been developed utilizing fluid-flow fractionation (FFF) methods to determine adsorption density distributions across the size spectrum of a particulate sample. The sedimentation FFF separation technique was used to study the interaction of the nutrient orthophosphate (32P labelled) and the herbicides glyphosate and atrazine (both 14C labelled) with suspended particulate matter obtained from the Darling, Murray, and Yarra rivers in Australia. Results of the investigation indicate that significant amounts of phosphate and glyphosate adsorbed to the particles, but very little of the less polar herbicide, atrazine, was adsorbed. In addition, it was determined that the smaller particles contained the highest pollutant content. This has important implications for pollutant transport in aquatic systems, since these particles will usually remain in suspension until an aggregation process occurs to induce settling and deposition. (Korn-PTT)
W91-03879

MERCURY CONTAMINATION LEVELS AND DISTRIBUTION IN TISSUES AND ORGANS OF DELPHINIDS (STENELLA ATTENUATA) FROM EASTERN TROPICAL PACIFIC, IN RELATION TO BIOLOGICAL AND ECOLOGICAL FACTORS.
Bordeaux-1 Univ., Talence (France). Lab. d'Ecologie Fondamentale et d'Ecotoxicologie.
J. M. Andre, F. Ribeyre, and A. Boudou.
Marine Environmental Research MERSDW, Vol. 30, No. 1, p 43-72, 1990. 6 fig, 3 tab, 71 ref.

Descriptors: *Bioaccumulation, *Cetoceans, *Mercury, *Path of pollutants, *Tissue analysis, Blood, Distribution patterns, Ecological effects, Food chains.

Based on a sample of 44 dolphins belonging to the Stenella attenuata species and captured in the Eastern tropical zone of the Pacific Ocean, this study was devoted to the analysis of the total mercury accumulation levels and distribution in 18 organs or tissue samples. The average concentration measured varied from 0.36 mg Hg/kg in the blood, to 62 mg Hg/kg in the liver, skeletal muscle and blubber, containing almost 95% of the estimated total burden present in the organs collected. The mercury distribution in the organs is an indication that the trophic contamination route, via the marine alimentary networks, may play a leading role with regard to the uptake of the metal. The different biological and ecological factors taken into account such as age, body weight, sex, or geographical origin, interact with the mercury concentrations and burdens in the collected organs or tissues. This is not confirmed for the date of capture, but the location of the capture area appears to be of prime importance, especially the latitude. The accumulation levels in the organs increase when the capture site is nearer the equator. (Author's abstract)
W91-03884

HEAVY METAL ACCUMULATION BY BARNACLES AND ITS IMPLICATIONS FOR THEIR USE AS BIOLOGICAL MONITORS.
Victoria Univ. of Manchester (England). Dept. of Environmental Biology.
For primary bibliographic entry see Field 5A.
W91-03886

SALINE SEEPAGE AND LAND DEGRADATION--A NEW SOUTH WALES PERSPECTIVE.
Soil Conservation Service of New South Wales, Sydney (Australia).
P. E. V. Charman, and R. S. Junor.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 195-203, 1990. 4 fig, 2 tab, 24 ref.

Descriptors: *Australia, *Environmental impact, *Environmental policy, *Geochemistry, *Saline groundwater, *Saline soils, *Saline water systems, *Water pollution sources, *Water resources management, Geohydrology, Geomorphology, Irrigation effects, Research priorities, Salts, Seepage, Soil conservation, Soil management, Vegetation effects, Water conservation, Water quality control.

Increasing salinization of both land and water in the Murray Basin in southeastern Australia is now widely recognized as contributing significantly to environmental degradation. Dryland salinization is generally a result of saline water discharge associated with non-irrigated land, adversely affecting soils, vegetation and water resources, as well as creating a form of degradation which reduces the economic and aesthetic value of the land which is not easy to correct. The Soil and Conservation Service of New South Wales is oriented primarily to erosion control and the rehabilitation of eroded land, and therefore is involved in treating dryland salinity. Factors which cause saline water discharge include: vegetation, clearing, sources of salt, geology and geomorphology, soil types, climate, and land use. Salinity affects soils, vegetation, erosion and water resources. Dryland salinity requires control and prevention. The three long-term research needs of the seepage salting problem are in the areas of recharge research, water table monitoring, and model development. The Soil Conservation Service is planning a number of major programs to address the salinization problem; the expertise present in many organizations must be used in cooperative programs. Current knowledge can prevent the impending disaster, given the required level of cooperation and commitment. (Fish-PTT)
W91-03893

VEGETATION AND CLIMATE OF THE LATE CAINOZOIC IN THE MURRAY BASIN AND

THEIR BEARING ON THE SALINITY PROBLEM.
New South Wales Univ., Kensington (Australia). School of Biological Sciences.
For primary bibliographic entry see Field 2A.
W91-03903

DEVICE FOR IN SITU DETERMINATION OF GEOCHEMICAL TRANSPORT PARAMETERS: 2. BIOCHEMICAL REACTIONS.
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 7B.
W91-03909

FIELD EVIDENCE FOR THE EFFECT OF ACETATE ON LEACHATE ALKALINITY.
Water and Earth Science Associates Ltd., Kitchener (Ontario).
J. F. Devlin.
Ground Water GRWAAP, Vol. 28, No. 6, p 863-867, November/December 1990. 4 fig, 15 ref.

Descriptors: *Alkalinity, *Field tests, *Groundwater quality, *Leachates, *Water chemistry, *Water quality, Acetates, Alkaline water, Carbonates, Chemical analysis, Fatty acids, Geochemistry, Landfills, Methanogenesis, Organic acids, Plumes, Subsurface mapping, Volatile organic compounds.

Alkalinity measurements are routinely conducted as part of standard water quality determinations. Often, very little interpretation of the values is attempted, and the entire alkalinity is attributed to carbonate or bicarbonate. When landfill leachates are involved, this assumption could be misleading in terms of plume mapping, determining the incrustation potential of the water, or assessing the likelihood of methane generation because substances other than carbonate, for example acetate, can contribute significantly to the sample's alkalinity. A set of landfill leachate samples was collected and analyzed for alkalinity and volatile fatty acids. Acetate was the only organic acid identified. A very strong correlation was observed between acetate and alkalinity. Actual titration curves (volume of acid vs. pH) were compared with curves calculated assuming that acetate and bicarbonate were the two major species contributing the total alkalinity. Excellent agreement was observed between the experimental and theoretical data. Distinct differences in the shapes of the curves for carbonate-dominated and acetate-dominated alkalinities make it possible to distinguish these two classes of water solely on the basis of alkalinity measurements. Water containing acetate titrates with an equivalence point which is less distinct than water containing only carbonate. (Author's abstract)
W91-03910

PARTICLE-TRACKING ANALYSIS OF FLOW PATHS AND TRAVELTIMES FORM HYPOTHETICAL SPILL SITES WITHIN THE CAPTURE AREA OF A WELLFIELD.
Ohio State Univ., Columbus. Dept. of Geology and Mineralogy.
E. S. Bair, R. A. Sheets, and S. M. Eberts.
Ground Water GRWAAP, Vol. 28, No. 6, p 884-892, November/December 1990. 8 fig, 2 tab, 12 ref.

Descriptors: *Flow pattern, *Groundwater movement, *Hydrologic models, *Path of pollutants, *Spills, *Tracking techniques, *Traveltime, Advection, Aquifers, Big Walnut Creek, Flow, Flow velocity, Glacial aquifers, Highways, Ohio, Scioto River, Simulation analysis, Velocity potential, Well pumping.

Velocity fields computed from simulated flows from a steady-state, three-dimensional numerical model of a glacial-drift/carbonate-bedrock aquifer system were used in conjunction with a particle-tracking program to delineate traveltime-related capture areas of a municipal wellfield and to compute flow paths and advective traveltimes from hypothetical spill sites located along interstate highways and heavily-traveled state routes. Results indicate the municipal wells operated by the City of Columbus, Ohio, capture flow from certain highway segments but other discharge points, including quarry-dewatering systems, the Scioto River, and Big Walnut Creek, capture flow from other highway segments. Advective traveltimes from three hypothetical spill sites to municipal wells range from 900 to 5,100 days under normal pumping rates and from 450 to 3,100 days under estimated maximum pumping rates. The 2,000-day capture area of the wellfield is approximately 30% larger (16 square miles) and contains approximately 4.5 more miles of highway under estimated maximum pumping rates compared to normal pumping rates. (Author's abstract)
W91-03913

INFLUENCE OF AQUIFER HETEROGENEITY ON CONTAMINANT TRANSPORT AT THE HANFORD SITE.
Colorado School of Mines, Golden. Dept. of Geology and Geological Engineering.
E. Poeter, and D. R. Gaylord.
Ground Water GRWAAP, Vol. 28, No. 6, p 900-909, November/December 1990. 6 fig, 40 ref. DOE Contract DE-AC06-76RL0 1830; Northwest College and University Association for Science (University of Washington) contract DE-AM06-76-RL02225 with the Department of Energy.

Descriptors: *Aquifer characteristics, *Geohydrology, *Groundwater pollution, *Hanford Site, *Heterogeneity, *Path of pollutants, *Radioactive wastes, Borehole geophysics, Geologic mapping, Hydraulic properties, Lithology, Model studies, Parametric hydrology, Plumes, Tritium, Unconfined aquifers, Washington, Water pollution control.

Aquifer heterogeneities defined by mapping and correlating lithofacies derived from existing geologic and borehole geophysical data at the U.S. Department of Energy's Hanford Site in south-central Washington, were compared to tritium migration trends within the unconfined aquifer. Lithofacies percentage maps proved useful in defining large-scale (on the order of miles) tritium pathways at Hanford but were not sufficiently detailed to serve as unambiguous predictors of these pathways. Results suggest that: (1) incorporation of geologic parameters more closely related to hydraulic properties (e.g., quantified grain size and sorting, degree of cementation, packing arrangement, sedimentary structures, and grain shape); and (2) conscientious integration of all geohydrological data at the Hanford Site (and elsewhere) will allow definition of three-dimensional aquifer elements termed 'hydrofacies' and enhance reliable prediction of contaminant migration pathways. Strict reliance on standard fluvial models in the evaluation of lithofacies at Hanford is not appropriate for predicting plume migration because of the complex depositional and erosional history of the sediments comprising the unconfined aquifer. Use of 'hydrofacies' ultimately may serve as the appropriate conceptual framework for predicting plume migration. (Author's abstract)
W91-03915

5C. Effects Of Pollution

SEDIMENT-TRANSPORT CHARACTERISTICS AND EFFECTS OF SEDIMENT TRANSPORT ON BENTHIC INVERTEBRATES IN THE FOUNTAIN CREEK DRAINAGE BASIN UPSTREAM FROM WIDEFIELD, SOUTHEASTERN COLORADO, 1985-88.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 2J.
W91-02963

STATUS OF BIOASSESSMENT ACTIVITIES IN THE U.S. FISH AND WILDLIFE SERVICE.
Fish and Wildlife Service, Washington, DC. Div. of Environmental Contaminants.
For primary bibliographic entry see Field 5A.
W91-03045

USE OF A FORESTED WETLAND IN SOUTH CAROLINA FOR TERTIARY TREATMENT OF MUNICIPAL WASTEWATER.
CH2M Hill, Charleston, SC.
For primary bibliographic entry see Field 5D.
W91-03060

ADIRONDACK WATERSHED DATA BASE: ATTRIBUTE AND MAPPING INFORMATION FOR REGIONAL ACIDIC DEPOSITION STUDIES.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 7C.
W91-03234

ANALYSIS OF THE HEALTH RISK FROM INGESTED RADON.
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
D. J. Crawford-Brown.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 17-26. 2 fig, 4 tab, 16 ref.

Descriptors: *Drinking water, *Radioisotopes, *Radon, *Risk assessment, *Risks, *Water pollution effects, Cancer, Dose-response relationships, Path of pollutants, Water quality.

The solubility coefficient of radon in fat is significantly higher than that for water. It is generally assumed that doses of radon to fatty tissues will be higher than those to other systemic tissues. Any long-term retention of radon in the body may be dominated by the content in fatty tissue. This assumption has not been demonstrated to date. The most detailed organ-specific measurements of radon were performed at Massachusetts General Hospital as part of the Environmental Protection Agency (EPA) effort to regulate radon. From this information a compartmental model for the movement of radon through the human body was developed. These compartments are assumed to be: (1) the stomach, (2) the small intestine, (3) the upper large intestine, (4) the lower large intestine, (5) the portal blood, liver and lung tissue, (6) the general body tissues (including fat), and (7) the air spaces of the lung (including pulmonary and tracheobronchial spaces). Using the EPA data, the concentration of radon in each compartment as a function of time was determined. The system of whole body effective dose equivalent adopted by the International Commission on Radiological Protection was employed to estimate risk. The results indicate that the lifetime risk is dominated by the risk to the stomach when ingestion is considered. The calculations support earlier findings that the risk of lung cancer is dominated by the inhalation pathway of exposure. (See also W91-03366) (Agostine-PTT)
W91-03368

RISK ASSESSMENT AND CONTROL MANAGEMENT OF RADON IN DRINKING WATER.
Oak Ridge Associated Universities, Inc., Washington, DC.
For primary bibliographic entry see Field 5F.
W91-03369

TOXICITY OF SEDIMENTS FROM WESTERN LAKE ERIE AND THE MAUMEE RIVER AT TOLEDO, OHIO, 1987: IMPLICATIONS FOR CURRENT DREDGED MATERIAL DISPOSAL PRACTICES.
Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife.
R. A. Hoke, J. P. Giesy, G. T. Ankley, J. L. Newsted, and J. R. Adams.
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 3, p 457-470, 1990. 1 fig, 6 tab, 25 ref.

Descriptors: *Dredging, *Fluvial sediments, *Lake Erie, *Lake sediments, *Maumee River, *Path of pollutants, *Toxicity, *Water pollution effects, *Water pollution sources, Benthos, Bioaccumulation, Daphnia, Ecological effects, Macroinvertebrates, Microtox assay, Midges.

The toxicity of sediments in the Maumee River, the Maumee River-western Lake Erie federal navi-

gation channel, and selected areas of western Lake Erie was measured using four assays: Photobacterium phosphoreum 15-minute bioluminescence inhibition (Microtox) in sediment pore waters and elutriates; Ceriodaphnia dubia 7-day survival and reproduction; Pimephales promelas 7-day larval survival and growth in sediment elutriates; and Chironomus tentans 10-day growth inhibition in whole sediments. The Microtox assay generally was the most sensitive of the four assays. Sediment elutriates were always equally or more toxic than pore waters from the same location when tested using the Microtox assay. The greatest toxicity in the Microtox and C. tentans assays was observed with pore waters or elutriates and sediments collected near point sources of contaminants to the Maumee River. Very little toxicity was observed in any assay using open-lake navigation channel or disposal site sediments or sediment extracts. Sediments from the Lake Erie portion of the navigation channel were suitable for open-lake disposal based on the lack of observed effects in the four assays. Toxicity of sediment from the open lake disposal site was similar to that of sediments from other locations in the western basin of Lake Erie which have not been impacted by dredged material disposal events. Sediments from near point sources such as industrial discharges, liquid unloading facilities, or sewage treatment plant outfalls on the Maumee River represent potential sources of toxicity for downstream resuspension and distribution. Further studies will be necessary to delineate the exact distribution of contaminated sediments near the point source discharges to the Maumee River. (Author's abstract)
W91-03409

IMPACT OF GLOBAL WARMING AND COOLING ON MIDWESTERN AGRICULTURE.
Iowa State Univ., Ames. Dept. of Agronomy.
L. M. Thompson.
Journal of the Iowa Academy of Science JIASEB, Vol. 97, No. 3, p 88-90, September 1990. 3 fig, 11 ref.

Descriptors: *Agricultural watersheds, *Drought effects, *Global warming, *Greenhouse effect, *Weather patterns, Air temperature, Atmosphere, Climatology, Crop production, Iowa, Meteorology, Temperature effects.

The global warming trend since 1980 has been greater than it was during the warming trend from 1880 to 1940. This has caused concern that the very warm years of 1987 and 1988 might have been associated with greenhouse warming. However, the cooling trend from 1940 to 1980 occurred during a rapid buildup in greenhouse gases in the atmosphere. Although there may have been some greenhouse warming since 1880, the unusual warmth of 1987 and 1988 may have been caused by changes in the temperature of the equatorial Pacific Ocean, and changes in transparency of the atmosphere or other phenomena acting on the atmosphere. There have been changes in weather variability associated with the global warming and cooling. The unusually benign period of weather in the Midwest from 1956 to 1973 occurred at the end of a brief period of global cooling. Since 1973, there has been increased weather variability like that experienced in the 1930s. The most important factor in weather variability in the Midwest has been associated with the El Nino cycle. Crop production appears to be favored in years of El Nino events. All the major droughts in the Midwest since 1891 have occurred between El Nino years. The El Nino event starts about every 3 to 7 years and lasts 1 to 2 years. In the Midwest the year after an El Nino event tends to be warmer and drier than normal and is sometimes a drought year. (Author's abstract)
W91-03429

RELATIONSHIP BETWEEN THE YEARLY CHANGES IN PHYTOPLANKTON OCCURRENCE AND NUTRIENT CONCENTRATION IN BRACKISH LAKE NAKANOUMI, 1974-1986.
Shimane Univ., Matsue (Japan). Environmental Science Lab.
K. Kondo, Y. Seike, and Y. Date.
Japanese Journal of Limnology RIZAAU, Vol. 51, No. 3, p 191-197, 1990. 4 fig, 2 tab, 23 ref.

Descriptors: *Eutrophication, *Japan, *Lake Nakanoumi, *Limnology, *Nutrient concentrations, *Phytoplankton, *Saline lakes, *Water pollution effects, Algal blooms, Brackish water, Lakes, Nitrogen, Phosphorous, Population density, Seasonal variation, Species diversity, Statistical analysis.

Monthly surveys of phytoplankton occurrence were conducted from 1974 to 1986 at six stations in the brackish Lake Nakanoumi. The concentration of total nitrogen (TN) approximately doubled from 1975 to 1979 and, after reaching peaks between 1978 and 1982, TN concentrations remained the same or slowly decreased. The concentration of total phosphorous (TP) sharply increased from 1975 to 1978 at half of the sampling stations, with no general trend observed at the remaining stations. The mean numbers of phytoplankton cells tended to be large during 1975-1979, except for 1977. Red tides occurred frequently during this period. The number of phytoplankton species increased sharply from 1974 to 1978. Thus, both the numbers of phytoplankton cells and species tended to increase during the periods when TN concentrations increased, and decreased when TN concentrations remained at the same level or gradually decreased. However, statistical analysis indicated that the fluctuation of nutrient concentration did not directly affect the number of phytoplankton cells, while nutrient concentrations were related to numbers of species at some of the sampling stations. Among four diversity indices for the phytoplankton community (i.e., Patten, Shannon, Simpson, and Margalef), only the Margalef index showed a highly positive correlation (coefficient >0.7) with the annual change in TP or TN concentration at some stations. (MacKeen-PTT)
W91-03457

TRANSFER OF TOXIC CONCENTRATIONS OF SELENIUM FROM PARENT TO PROGENY IN THE FATHEAD MINNOW (PIMEPHALES PROMELAS).
Environmental Research Lab.-Duluth, Monticello, MN. Monticello Ecological Research Station.
R. Schultz, and R. Hernamutz.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 4, p 568-573, October 1990. 2 tab, 11 ref.

Descriptors: *Bioaccumulation, *Ecotoxicology, *Fathead minnows, *Path of pollutants, *Selenium, *Toxicology, *Water pollution effects, Ecological effects, Fish eggs, Fish physiology, Toxicity, Water pollution.

Selenium may become concentrated in aquatic ecosystems to levels that are toxic to fish. Research has shown occurrences of edema and lordosis in the larvae of fathead minnows (Pimephales promelas) exposed to 10 microgram/L selenium in experimental streams. Selenium levels within fathead minnow embryos in a semi-natural ecosystem were examined to determine whether selenium levels resulted from direct uptake by the embryos following spawning, from female-to-progeny transferral, or from some combination of these two occurrences. Embryos and ovaries from fatheads raised in control and 10 microgram/L selenium streams were collected and analyzed for selenium content. Selenium uptake was analyzed over a 24-hour period by embryos from control streams when placed in 10 microgram/L selenium water, and occurrences of edema and lordosis in larvae were compared. A higher incidence of edema and lordosis was found to occur in fathead minnow larvae from 10 microgram/L streams versus larvae from control streams. The highest incidence was usually noted on day four. A significant difference also existed between the amount of selenium accumulated by embryos spawned in streams containing 10 microgram/L selenium and embryos spawned in control streams. Embryos from fish reared in the dosed streams contained selenium levels 13 times higher than embryos from fish reared in the control streams. The hypothesis that selenium is passed from female to progeny in fathead minnows is supported by the similarity in residues of selenium between embryos and ovaries within the same treatment, and the lack of significant uptake of selenium by control embryos exposed to water containing selenium. In addition, this passage of selenium has been found to result in toxic effects demonstrated by the increased incidence of edema and lordosis. Larvae exhibiting these characteristics are not expected to survive in natural systems. (Mertz-PTT)
W91-03471

EFFECTS OF TRIBUTYLTIN OXIDE ON THE SKELETAL STRUCTURES OF DEVELOPING AND REGENERATING LIMBS OF THE AXOLOTL LARVAE, AMBYSTOMA MEXICANUM.
Guelph Univ. (Ontario). Dept. of Zoology.
S. R. Scadding.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 4, p 574-581, October 1990. 1 fig, 1 tab, 20 ref.

Descriptors: *Antifoulants, *Ecotoxicology, *Organotin compounds, *Salamanders, *Teratogenic effects, *Toxicology, *Water pollution effects, Differentiation, Pesticides, Physiological effects, Regeneration, Toxicity, Water pollution.

Tributyltin is used as an antifouling agent in marine paints because it is a potent biocide and is very effective at preventing marine organisms such as barnacles from settling on the hulls of boats. Tributyltin, however, is clearly toxic to a variety of marine invertebrates. The potential teratogenicity of tributyltin in vertebrates, particularly teratogenic effects on developing or regenerating limbs, was investigated on the axolotl, Ambystoma mexicanum. Axolotl larvae were obtained as eggs or young larvae from the axolotl colony at the University of Ottawa, and treated with tributyltin by adding it to the water in their bowls. Tributyltin was mixed with acetone and serially diluted with tap water to reach final concentrations of 50, 15, 5, 1.5, or 0.5 microgram/L. Tributyltin was clearly toxic at the higher dose levels. All axolotl larvae exposed to 50 microgram/L died within 24 hours and most exposed to 15 microgram/L died within 7 days. The skeletal patterns of the limbs developing in the presence of 0.5 microgram/L tributyltin were indistinguishable from those of the controls. However, the hindlimbs exposed to 1.5 microgram/L tributyltin showed a slightly increased incidence of skeletal deletions. At the 5 microgram/L level, only 3 out of 20 limbs were complete. Surprisingly, tributyltin at concentrations of up to 5 microgram/L did not cause any derangement of the skeletal pattern of the regenerating forelimbs, even though the concentration (5 microgram/L) approached levels that were lethal. The observation that tributyltin was teratogenic during limb development but not during limb regeneration raised the possibility that the two processes are different in some way to allow differential responses to tributyltin. (Mertz-PTT)
W91-03472

ACUTE TOXICITY TO JUVENILE PACIFIC SALMONIDS AND RAINBOW TROUT OF BUTOXYETHYL ESTERS OF 2,4-D, 2,4-DP AND THEIR FORMULATED PRODUCT: WEEDONE CB AND ITS CARRIER.
Environmental Protection Service, West Vancouver (British Columbia). Pacific and Yukon Region.
M. T. Wan, R. G. Watts, and D. J. Moul.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 4, p 604-611, October 1990. 6 tab, 10 ref.

Descriptors: *Ecotoxicology, *Herbicides, *Salmon, *Toxicology, *Trout, *Water pollution effects, Esters, Fuel, Toxicity, Water pollution, Weedone CB.

Butoxyethyl esters of 2,4-dichlorophenoxyacetic acid and 2-(2,4-dichlorophenoxy)propionic acid are base chemicals manufactured for formulating Weedone CB. The use of Weedone CB for forestry conifer release and industrial rights-of-way programs in coastal British Columbia may result in the accidental introduction of butoxyethyl esters into water bodies inhabited by anadromous fish. The acute toxicity of butoxyethyl esters, Weedone CB and its carriers to juvenile salmonids of the Pacific

Northwest was examined. A series of 96-hour static acute toxicity tests was conducted in fresh water using several species of juvenile salmonids. The measured concentrations of 2,4-dichlorophenoxyacetic acid and 2-(2,4-dichlorophenoxy)propionic acid in different water types in the coho test vessels before fish introduction was much less than the corresponding theoretical concentration. The data suggest that losses of these butoxyethyl esters occurred in both the technical and formulated products. Losses for butoxyethyl esters and Weedone were apparently greater in soft, acidic water than in hard, alkaline water. Results showed that the butoxyethyl esters, Weedone, and Weedone combined with carriers was highly toxic to salmonids. They were more toxic to young salmon than the carriers (Carrier A (proprietary formulation) and diesel oil), irrespective of water type. Carrier A was much more toxic to the fish than diesel oil. The acute toxicity to salmonids of 2,4-dichlorophenoxyacetic acid and Weedone with carriers, but not 2-(2,4-dichlorophenoxy)propionic acid and plain Weedone, was affected by the characteristics of water. At the manufacturer's recommended rate of application (50 L product/hectare), the potential to generate concentrations acutely toxic to salmonids is high in streams unintentionally oversprayed. Pink salmon were much more sensitive to the diesel oil carrier when compared to coho salmon and rainbow trout. (Mertz-PTT)
W91-03473

MACROFAUNA OF ELODEIDS OF TWO LAKES OF DIFFERENT TROPHY. I. RELATIONSHIPS BETWEEN PLANTS AND STRUCTURE OF FAUNA COLONIZING THEM.
Akademia Rolnicza, Lublin (Poland). Dept. of Zoology and Hydrobiology.
For primary bibliographic entry see Field 2H.
W91-03477

ACCUMULATION OF METALS AND THEIR TOXICITY IN THE MARINE INTERTIDAL INVERTEBRATES CERASTODERMA EDULE, MACOMA BALTHICA, ARENICOLA MARINA EXPOSED TO PULVERISED FUEL ASH IN MESOCOSMS.
Kema N.V., Arnhem (Netherlands). Dept. of Environmental Research.
H. A. Jenner, and T. Bowmer.
Environmental Pollution ENPOEK, Vol. 66, No. 2, p 139-156, 1990. 4 fig, 3 tab, 24 ref.

Descriptors: *Ash, *Benthic environment, *Bioaccumulation, *Ecological effects, *Heavy metals, *Path of pollutants, *Waste disposal, *Water pollution effects, Annelids, Arsenic, Bivalves, Electric power, Environmental effects, Mortality, Zinc.

Coal-fired generating stations produce two types of solid waste, bottom boiler ash and pulverized fuel ash. The pulverized fuel ash is collected on electrostatic filters from the flue gases. Although in western Europe, Japan and the United States, a large proportion of pulverized fuel ash is utilized in the building industry, substantial amounts remain, creating a sizeable disposal problem. The biological effects from metals accumulating from pulverized fuel ash were investigated in three intertidal benthic invertebrates. After the first run of 90 days, high mortality was found in the lugworm Arenicola marina. After intermittent exposure to pulverized fuel ash, high mortality was also found for the cockle Cerastoderma edule. No mortality occurred with the baltic tellin Macoma balthica. Metal accumulation differed widely among the species. A. marina accumulated As to high levels from pulverized fuel ash mixtures, which may be attributed to changes in the redox potential of the sediment. It also appeared that Zn levels in M. balthica tissue, for both control and exposed animals, were apparently normal but extremely high. Disposal of pulverized fuel ash in marine coastal waters will radically affect community structure at the dumping site. Accumulation of certain elements like As will be favored in the mixing zone at the borders of a dump site due to a higher organic content and consequent higher bioavailability. (Mertz-PTT)
W91-03481

IMPACT OF MILD EXPERIMENTAL ACIDIFICATION ON SHORT TERM INVERTEBRATE DRIFT IN A SENSITIVE BRITISH COLUMBIA STREAM.
British Columbia Univ., Vancouver. Dept. of Zoology.
D. P. Bernard, W. E. Neill, and L. Rowe.
Hydrobiologia HYDRB8, Vol. 203, No. 1/2, p 63-72, September 14, 1990. 1 fig, 2 tab, 38 ref.

Descriptors: *Acid rain, *Acid streams, *Acidification, *Aluminum, *Aquatic drift, *British Columbia, *Invertebrates, *Mountain streams, *Stream ecology, *Water pollution effects, Animal behavior, Caddisflies, Hydrogen ion concentration, Insects, Midges, Population density, Precipitation, Snowmelt.

The deposition of acidic atmospheric pollutants of anthropogenic origin has resulted in recent acidification of surface waters in eastern North America and northern Europe. Streams undergoing acidification often suffer rapid pH depressions during rainstorms and/or snowmelt events, accompanied by increases in dissolved aluminum which is mobilized from sediments and soils in the surrounding catchment. Both H(+) and Al(+3) are toxic to many stream invertebrates and vertebrates. Long term exposures to acidification have been associated with changes in species diversity, composition, and abundance in lakes and streams. Daytime drift behavior of lotic macroinvertebrates was studied following short term (12 h) additions of HCl or HCl plus AlCl3 to a circumneutral soft water (alkalinity ca. 100 microeq/L) mountain stream in British Columbia, Canada. Addition of HCl (pH reduced from 7.0 to 5.9) resulted in an overall tripling of invertebrate drift density with rapid (<1 h) increases in chironomid Diptera and Trichoptera. Small Ephemeroptera also entered the drift at high densities, but were delayed about 6 h. Addition of AlCl3 (0.71 to 0.95 mg/L total Al(+3)) in HCl (stream pH reduced to 5.9) resulted in an overall 6-fold increase in invertebrate drift, with rapid increases by Ephemeroptera and delayed responses by chironomids and Trichoptera. These results suggest that the behavior of several macroinvertebrates from low alkalinity, unacidified streams can be altered by simulations of short-term, mild acidic deposition events. Further, the magnitude and timing of entry into the drift varies among taxonomic groups with the presence or absence of low concentrations of aluminum ions. (Author's abstract)
W91-03497

TOXICITY OF HEAVY METALS TO ASELLUS AQUATICUS (L.) (CRUSTACEA, ISOPODA).
Naples Univ. (Italy). Dipt. Genetica, Biologia Generale e Molecolare.
L. Migliore, and M. de Nicola Giudici.
Hydrobiologia HYDRB8, Vol. 203, No. 3, p 155-164, September 21, 1990. 8 fig, 6 tab, 27 ref.

Descriptors: *Crustaceans, *Heavy metals, *Isopods, *Pollution index, *Toxicity, *Toxicology, *Water pollution effects, Aquatic populations, Cadmium, Chromium, Copper, Ecosystems, Environmental impact, Food chains, Iron, Lead, Mercury, Nickel, Water quality standards, Zinc.

Agricultural and industrial activities cause environmental contamination by heavy metals which are harmful to all components of the community by their extreme toxicity. Crustaceans are among the most important elements of aquatic and marine food webs. Their sensitivity to heavy metals is well-documented. Effects of heavy metals on the isopod Asellus aquaticus were studied by static toxicity tests. Results demonstrate that the species is sensitive to Cd(+2), Cr(+6), Cu(+2), Fe(+3), Hg(+2), Ni(+2), Pb(+2), and Zn(+2), but the toxicity of each metal is different. Differences are also found between adults and juveniles. The comparative analysis of all data on the toxicity has been performed on the concentrations of metal ions and not on metal compound concentrations. To correctly state a threshold for these metals which is compatible with the survival of Asellus aquaticus, it is necessary to examine the effects on all the components of its population. Moreover, toxicity tests should be extended to this and similar species which can be usefully employed to determine suitable standards for the stability of freshwater communities. (Fish-PTT)
W91-03501

IMPACT OF INADEQUATE SANITARY CONDITIONS ON HEALTH IN DEVELOPING COUNTRIES.
London School of Hygiene and Tropical Medicine (England). Maternal and Child Epidemiology Unit.
S. R. A. Huttly.
World Health Statistics Quarterly WHSQDQ, Vol. 43, No. 3, p 118-126, 1990. 1 fig, 1 tab, 57 ref.

Descriptors: *Developing countries, *Impaired water quality, *Public health, *Sanitation, *Water pollution effects, Drinking water, Education, Human diseases, Nematodes, Sanitary engineering.

One of the achievements of the International Drinking Water Supply and Sanitation Decade (1981-1990) is a better understanding of the relationship between poor sanitary conditions and health. A review of current knowledge of the major water-related and excreta-related diseases considers four health indicators: diarrheal diseases, soil-transmitted nematode infections, dracunculiasis (guinea-worm disease), and nutritional status. These constitute some of the major health problems in the developing world. Although there are large variations in morbidity and mortality rates between and within geographical areas, some global estimates have been made. Children under 5 years of age experience a diarrheal mortality rate of 12 per 1,000 (4 million diarrhea-associated deaths per year). Approximately 1 billion people are believed to be infected with Ascaris lumbricoides, 900 million with hookworms, and 500 million with Trichuris trichiura. Dracunculiasis may infect 10 million people each year. The complex issues involved in measuring the health impact of improved sanitary facilities, the differences in sanitary improvements and environmental settings, and the diverse nature of the health indicators all contribute substantial variations in the health impact observed. There is good evidence that sanitary improvements have multiple health benefits, direct and indirect, both in the short and the long term. During recent years, many recommendations have been made, including emphasis on technological issues and on behavior-related factors. An integrated approach has been advocated, involving hardware implementation alongside appropriate education in order to maximize facility usage and hygienic practices and to bring about the desired health benefits. (Fish-PTT)
W91-03505

HEALTH RISKS ASSOCIATED WITH POLLUTION OF COASTAL BATHING WATERS.
World Health Organization, Athens (Greece). Coordinating Unit for the Mediterranean Action Plan.
L. J. Saliba, and R. Helmer.
World Health Statistics Quarterly WHSQDQ, Vol. 43, No. 3, p 177-187, 1990. 1 fig, 4 tab, 22 ref.

Descriptors: *Beach contamination, *Coastal waters, *Human diseases, *Public health, *Risk assessment, *Swimming, *Tourism, *Water pollution effects, Bacteria, Dose-response relationships, Epidemiology, Microbiological studies, Population exposure, Recreation, Sanitation, Viruses, Wastewater pollution.

A number of bacterial, viral, and other diseases can be contracted by man through exposure to sewage-polluted bathing water or beach sand. The increasing use of the sea for recreation has led to major concern regarding health hazards to both local and tourist populations. Epidemiological studies attempting to correlate microbiological water quality with health effects have produced different results, leading to a wide variation in recreational water quality criteria and standards applied, and to considerable controversy regarding their implementation. The Mediterranean provides a good example of a problem region. Coastal pollution by sewage is still a major concern and control measures vary considerably. A number of microbiological/epidemiological studies have been carried out

since 1953 in an attempt to define the levels of risk following exposure to different concentrations of bacteria in bathing waters. Practically all studies showed higher morbidity among bathers as compared to non-bathers, but correlation between specific symptoms and bacterial indicator concentrations varied considerably. On the basis of the 1972-1978 Cabelli Environmental Protection Agency (EPA) study in the U.S., later developed by EPA into a recommended health-effects criterion for marine recreational water, one would expect 25-40 gastrointestinal cases per 1,000 persons exposed to seawater containing 100 enterococci per 100 ml. Much more work is needed, however, before a satisfactory dose-response relationship is obtained, principally because of confounding factors inherent in all studies carried out so far, which still require a solution. (Fish-PTT)
W91-03506

EFFECTS OF TERRESTRIAL EFFLUENTS ON THE INCIDENCE OF AEROMONAS SPP. IN COASTAL WATERS.
Barcelona Univ. (Spain). Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W91-03521

ASSESSING TOXICITY OF DRINKING WATER CONTAMINANTS: AN OVERVIEW.
Vanderbilt Univ., Nashville, TN. Dept. of Biochemistry.
For primary bibliographic entry see Field 5A.
W91-03527

ROLE OF SHORT-TERM TESTS IN EVALUATING HEALTH EFFECTS ASSOCIATED WITH DRINKING WATER.
Environmental Protection Agency, Cincinnati, OH.
J. R. Meier, and F. B. Daniel.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 10, p 48-56, October 1990. 4 tab, 47 ref.

Descriptors: *Ames test, *Carcinogens, *Drinking water, *Mutagens, *Public health, *Risk assessment, *Testing procedures, *Water treatment, Bioassay, Chemical analysis, Health aspects, Water analysis.

Short-term bioassays such as the Ames test are used to assess genotoxicity and potential carcinogenicity of specific drinking water contaminants as well as concentrated samples of drinking water. When these tests are applied to complex mixtures such as drinking water, a number of additional factors complicate the interpretation of test results. These tests are based on the premise that DNA is the common target of mutagens and carcinogens regardless of the cell type of animal species. It is hoped that by using these bioassays, chemicals that pose a significant health hazard can be identified and measures to prevent or reduce human exposure can be implemented. Because of the uncertainties regarding the proper interpretation of test results, it is difficult to make firm recommendations on how best to apply these tests for assessing health risks in drinking water. The positive results that have been obtained using in vitro short-term tests for genotoxicity on chlorinated-drinking water concentrates indicate a certain real probability that the water contains human mutagens, carcinogens, or both. This finding in itself does not suggest that an imminent hazard to human health exists, but neither does it seem prudent to ignore this result. Although uncertainties regarding interpretation limit the application of short-term test for risk assessment, short-term tests provide public health officials with a useful tool for obtaining timely and cost-efficient information about potential health risks associated with drinking water. (Mertz-PTT)
W91-03528

CANCER RISK ASSESSMENT: IMPORTANCE OF IDENTIFYING MECHANISMS OF ACTION.
Washington State Univ., Pullman. Coll. of Pharmacy.
For primary bibliographic entry see Field 7B.
W91-03529

COMPARATIVE SUBCHRONIC TOXICITY STUDIES OF THREE DISINFECTANTS.
Health Effects Research Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5F.
W91-03530

HEPATOPATHOTOXICITY OF THREE PESTICIDES IN A FRESHWATER FISH, PUNTIUS CONCHONIUS HAM.
Jefferson Medical Coll., Philadelphia, PA. Dept. of Anatomy.
T. S. Gill, J. Pande, and H. Tewari.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 6, p 653-663, August 1990. 10 fig, 14 ref.

Descriptors: *Animal pathology, *Fish, *Liver, *Pesticides, *Population exposure, *Toxicology, *Water pollution effects, Carbamate pesticides, Chronic toxicity, Halogenated pesticides, Organophosphorus pesticides, Rosy Barb, Sublethal effects.

Liver pathology was evaluated in a freshwater fish, Puntius conchonius, chronically exposed to sublethal concentrations of pesticides: a carbamate (0.806 ppm aldicarb); an organophosphorus (109.5 ppm phosphamidon); and an organochlorine (6.72 ppb endosulfan). Aldicarb exposure led to extensive necrosis combined with nuclear pycnosis and karyolysis after 1 week and hypertrophy of hepatocytes and massive fatty degeneration of the liver after 4 weeks. Endosulfan poisoning evoked serious structural impairments including hepatocyte regression, vacuolization, and nuclear pycnosis. Hepatic lesions in fish exposed to phosphamidon included hepatocyte hypertrophy and nuclear deterioration. Focal necrotic changes were often noted in the treated fish. The carbamate pesticide proved to be more injurious to the liver as compared to the other two pesticides tested. (MacKeen-PTT)
W91-03536

TOXICITY BIOASSAYS: WATER POLLUTION EFFECTS ON AQUATIC ANIMALS AND PLANTS (JUN 86-FEB 90). CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE.
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 10C.
W91-03569

HEALTH ASSESSMENT FOR WHITTAKER CORPORATION NATIONAL PRIORITIES LIST (NPL) SITE, MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA, REGION 5, CERCLIS NO. MND006252233.
Agency for Toxic Substances and Disease Registry, Atlanta, GA.
For primary bibliographic entry see Field 5G.
W91-03574

TYPES AND EFFECTS OF MICROBIAL CONTAMINATION OF GROUNDWATER.
Environmental Protection Agency, Research Triangle Park, NC. Office of Research and Development.
For primary bibliographic entry see Field 5B.
W91-03577

SEDIMENT QUALITY VALUES REFINEMENT: VOLUME I. 1988 UPDATE AND EVALUATION OF PUGET SOUND AET (APPARENT EFFECTS THRESHOLD).
PTI Environmental Services, Bellevue, WA.
R. Barrick, S. Becker, L. Brown, H. Beller, and R. Pastorok.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-200398/AS. Price codes: AO9 in paper copy, AO1 in microfiche. Report No. EPA 910/9-88-246a. September 1988. 180p, 47 fig, 19 tab, 4 append. EPA Contract No. 68-01-4341.

Descriptors: *Data processing, *Environmental impact, *Puget Sound, *Sediment contamination, *Washington, *Water pollution effects, Amphipods, Benthic fauna, Bioassay, Metals, Microtox, Organic compounds, Oysters.

The Apparent Effects Threshold (AET) can be used to develop chemical specific sediment quality values. As part of this effort, AET values were generated for Puget Sound, Washington, and applied in a predictive manner to approximately 300 stations. The objective of this investigation was to test the reliability of AET, and potential sediment quality standards based on AET, in predicting adverse biological effects associated with sediment contamination. Of the 201 benthic infauna stations and 287 amphipod bioassay stations evaluated in this study, approximately 75% were in accordance with AET predictions. Approximately 96% of the 50 stations where oyster larvae and microtox bioassays were performed were in accordance with AET predictions. Based on AET for the four biological indicators, Puget Sound maps were produced showing the location of predicted impacts in the estuary. This effort involved the generation and evaluation of AET for 58 metal and organic chemicals. (Author's abstract)
W91-03583

EFFECTS OF HEAVY METALS IN SEDIMENTS ON THE MACROINVERTEBRATE COMMUNITY IN THE SHORT CREEK/EMPIRE LAKE AQUATIC SYSTEM, CHEROKEE COUNTY, KANSAS: A RECOMMENDATION FOR SITE-SPECIFIC CRITERIA.
Environmental Protection Agency, Kansas City, KS. Environmental Services Div.
J. Jobe.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-189773. Price codes: A04 in paper copy, A01 in microfiche. EPA Report No. 600/9-89/018, October 1988. 48p, 11 fig, 6 tab, 13 ref. EPA Grant No. U-913001-01-0.

Descriptors: *Empire Lake, *Heavy metals, *Macroinvertebrates, *Short Creek, *Water pollution effects, Cadmium, Ecological effects, Environmental effects, Kansas, Lead, Manganese, Path of pollutants, Species diversity, Standards, Statistical analysis, Zinc.

Cherokee County, Kansas, was the site of the most intensive mining in the tri-state mining area. Little cleanup of the tailings and waste materials from smelting operations has been done. This study uses statistical analysis techniques to determine the effects of four heavy metals (cadmium, lead, manganese, and zinc) on the macroinvertebrate community using the data collected in the fall 1987. The concentrations of all four metals were found to be greatly elevated throughout Empire Lake and in both the Spring River and Shoal Creek arms of the reservoir. The concentrations of all four metals were found to be greatly elevated throughout Empire Lake and both the Spring River and Shoal Creek arms of the reservoir. The mean concentration of Cd was 21.61 ppm with a range of 4.11 ppm to 131.50 ppm. The mean concentration of Pb was 189.92 ppm with a range of 52.90 ppm to 1607 ppm. The mean concentration of Mn was 648.57 ppm with a range of 248.5 ppm to 1937 ppm. The mean concentration of Zn was 3052.05 ppm with a range of 185.50 ppm to 25008.00 ppm. The mean density of macroinvertebrates in the study was 1,063.6/sq m with a range of 129.2/sq m to 5,382.8/sq m. The mean number of species found per Surber sampler was 5.8 with a range of 1 to 18. The total number of species found in the study was 32. However, 30 of these species were found in one transect. Many were represented by only one individual. There were only 14 species that were represented by 17 or more individuals. It was concluded that density and species richness were greatly reduced. The results of several statistical tests indicate that site specific sediment criteria for the four metals should be as follows: Mn should not exceed the range of 450-600 ppm; Cd should not exceed 10-27 ppm; Zn should not exceed the range of

1354-2190 ppm; and the combined levels of Mn and Pb should not exceed 600 ppm. These concentrations provide upper bounds to the maximum allowable levels. Since all of the information for this study was based on communities in an impacted reservoir, it may be that safe levels are much lower than this study suggests. Also, additional variables not in the current analysis, such as sediment type, amount of organic debris and season, could have a significant affect upon the model. (Lantz-PTT)
W91-03588

SEDIMENT QUALITY VALUES REFINEMENT: VOLUME 1 - DATA APPENDICES, 1988 UPDATE AND EVALUATION OF PUGET SOUND AET.
PTI Environmental Services, Bellevue, WA.
For primary bibliographic entry see Field 5A.
W91-03599

CYCLE IN THE SYSTEM SOIL-PLANT-ANIMAL ON LOCATIONS WITH EXTREMELY HIGH SOIL CONTAMINATION BY CADMIUM AND NICKEL CAUSED BY SEWAGE-SLUDGE (KREISLAUF IM SYSTEM BODEN-PFLANZE-NUTZTIER AUF STANDORTEN MIT EXTREM HOHER CADMIUM-UND NICKELBELASTUNG DURCH KLARSCHLAMM-MAUFBRINGUNG).
Landwirtschaftliche Untersuchungs- und Forschungsanstalt, Speyer (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W91-03602

MUSSELS (MYTILUS EDULIS L.) IN COASTAL WATER QUALITY CONTROL (DIE MIESMUSCHEL (MYTILUS EDULIS L.) ALS INDIKATOR VON UMWELTBELASTUNGEN).
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
For primary bibliographic entry see Field 5A.
W91-03605

WASTEWATER IRRIGATION IN DEVELOPING COUNTRIES: HEALTH EFFECTS AND TECHNICAL SOLUTIONS.
Hebrew Univ. of Jerusalem (Israel). School of Public Health.
For primary bibliographic entry see Field 3F.
W91-03650

ECONOMIC IMPLICATIONS OF GROUNDWATER CONTAMINATION TO COMPANIES AND CITIES.
Freshwater Foundation, Navarre, MN.
Freshwater Foundation, Navarre, Minnesota. 1989. 80p.

Descriptors: *Case studies, *Cleanup operations, *Economic aspects, *Groundwater pollution, *Groundwater quality, *Minnesota, *Site remediation, *Water pollution control, *Water pollution effects, Costs, Long-term planning, Monitoring, Water quality.

Groundwater contamination poses an important challenge to future economic development in Minnesota, as well as nationwide, threatening property values, tax revenues and business development. In this survey of 21 Minnesota cities and 18 companies, conservatively estimated, groundwater contamination resulted in the following costs: to 17 Minnesota cities, a total of $24,045,500; and to 18 Minnesota companies, a total of $43,026,500. In these few instances, groundwater pollution costs in Minnesota alone were estimated by the participants at over $67 million. This figure does not, however, take into account the large number of contaminated sites already identified in the state and currently in some stage of assessment or remediation. Nor does it include an estimated $13 million in jobs that could have come from potential new business in just one city, where prime commercial property has been compromised by pollution. Nor does it include the millions of dollars for cleanup, bottled water supplies, testing, and staff time from the Minnesota Pollution Control Agency, or Superfund monies for construction of new water treatment facilities. As monitoring increases, contamination from current and past practices will uncover additional cases. How equitable and efficiently Minnesota deals with these incidences will have a profound effect on the amount and distribution of economic development throughout the state. The economic impact of groundwater contamination offers an important market incentive to both cities and businesses to minimize the production of waste and more effectively address the long-term pollution and liability issues stemming from its disposal. In Minnesota, businesses have already spent millions of dollars on cleanup of waste sites that have contaminated groundwater or have the potential to contaminate groundwater. If businesses can't meet the growing future costs of cleanup, additional burdens will be passed on to the taxpayer. Cleanup and remediation are not a short-term expense; they are becoming a long-term liability. For the future, instead of monies spent on legal fees, consultants, and testing; good preventive manufacturing practices, sound waste management and minimization, and other preventive strategies will be needed to protect water quality--turning the short-term expense into a long-term investment. The economic issues related to groundwater contamination will serve as a catalyst to developing a more integrated framework for all land and water management. Both groundwater and economic resources will benefit from such new approaches. (Lantz-PTT)
W91-03660

COLONIAL WATERBIRD DEFORMITIES--AN EFFECT OF TOXIC CHEMICAL RESIDUES IN THE GREAT LAKES.
Ecological Research Service, Inc., Bay City, MI.
J. P. Ludwig, and H. Kurita.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 201-209, 33 ref.

Descriptors: *Bioindicators, *Great Lakes, *Teratogenic effects, *Water pollution effects, *Waterfowl, Aquatic life, Biological magnification, Chemical analysis, Dioxins, Ecosystems, Environmental impact, Food chains, Lake management, Polychlorinated biphenyls, Toxins, Water birds, Water quality management, Water resources management.

Colonial waterbirds have been recognized as sensitive monitors of toxic chemical contamination in the Great Lakes. Recent information suggests that, contrary to widely publicized evidence that amounts of total contamination of the Great Lakes biota is decreasing, reassurance is both premature and inaccurate. Furthermore, there are high rates of deformities of specific types of colonial waterbird species found over the last ten years, which can be reproduced in the laboratory by feeding PCB, dioxin, and furan contaminants to avian test species. Reproductive problems of the bird species include egg infertility, altered eggshells, structural embryonic deformities, and deformed young. Waterbird studies are useful in that birds cannot reabsorb abnormal embryos, and birds share a similar homeothermic metabolism with mammals. The multiplicity of toxins present in the foods consumed by both the birds and men that live in shared ecosystems demand a real world approach. The overall effects of toxics have increased in a variety of colonial waterbird species as the reported total PCB levels and other toxic concentration levels are declining. Clearly the birds are integrating their toxic burden differently than the analytical chemists and the policy-makers have predicted. The public would be best served by monitoring reproduction of the sensitive colonial waterbirds or aquatic mammals using standard protocols. In addition, by first looking for real toxic effects in wildlife and then testing those organisms that have bioconcentrated the worst materials to the maximum extent feasible, the analytical chemist should be able to take a step closer to actual fingerprinting of individual contamination plumes. (See also W91-03672) (Fish-PTT)
W91-03694

FADING RECOVERY: THE ROLE OF ROACH (RUTILUS RUTILUS L.) IN MAINTAINING HIGH PHYTOPLANKTON PRODUCTIVITY AND BIOMASS IN LAKE VESIJARVI, SOUTHERN FINLAND.
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
For primary bibliographic entry see Field 5G.
W91-03773

TOXICITY OF A SOLUBLE PEPTIDE FROM MICROCYSTIS SP. TO ZOOPLANKTON AND FISH.
Chile Univ., Santiago. Dept. de Biologia.
R. Penaloza, M. Rojas, I. Vila, and F. Zambrano.
Freshwater Biology FWBLAB, Vol. 42, No. 2, p 233-240, October 1990. 6 fig, 3 tab, 32 ref. FONDECYT Grant 178/88 and Departamento Tecnico de Investigacion, Universidad de Chile, Grant B 2811-8813.

Descriptors: *Algal toxins, *Bioassay, *Chile, *Cyanophyta, *Eutrophic lakes, *Limnology, *Toxicity, *Toxins, Daphnia, Fishkill, Hydrogen ion concentration, Peptides, Rotifers, Temperature, Zooplankton.

In order to determine the cause of fish kills in eutrophic Aculeo Lake (Chile) during blue-green algae blooms, the composition of the phytoplankton and its toxin content were analyzed. In addition, the lethal action of a partially-purified component from natural phytoplankton was investigated on zooplankton and on Gambusia affinis Holbrooki, a common fish in Aculeo Lake. It was found that the soluble fraction extraction was lethal to common native zooplankton, including the rotifers Keratella sp., Trichocerca similis, the copepod Boeckella sp., and the cladoceran Chydorus sphaericus, as well as to G. affinis. The specific toxicity of the soluble fraction from phytoplankton varied four-fold to six-fold with seasonal peaks during periods of warm temperature. The results showed that after cell disruption, the toxicity resides in the soluble fraction, which strongly suggests that the toxin is a natural component of the intracellular content, and not bound to a particulate structure of the cell. It is thought that the toxic peptide released from Microcystis may reach a concentration lethal to fishes, which through dilution produces a short-lived pulse. It is less likely that a chemical degradation process is involved because the toxic component remains unaltered despite large changes to pH and temperature (a temperature close to boiling is needed to deactivate the toxin). However, bacterial degradation of the toxin has not been excluded. (White-Reimer-PTT)
W91-03821

SUCCESSIONAL CHANGES IN THE SOFT-WATER MACROPHYTE VEGETATION OF (SUB)ATLANTIC, SANDY, LOWLAND, REGIONS DURING THIS CENTURY.
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
For primary bibliographic entry see Field 2H.
W91-03824

MACROFAUNA RECOLONIZATION OF SUBTIDAL SEDIMENTS. EXPERIMENTAL STUDIES ON DEFAUNATED SEDIMENT CONTAMINATED WITH CRUDE OIL IN TWO NORWEGIAN FJORDS WITH UNEQUAL EUTROPHICATION STATUS. I. COMMUNITY RESPONSES.
Norsk Inst. for Vannforskning, Oslo.
J. A. Berge.
Marine Ecology Progress Series MESEDT, Vol. 66, No. 1/2, p 103-115, September 1990. 11 fig, 6 tab, 40 ref. Norwegian Institute of Water Research Grant E-87720.

Descriptors: *Eutrophication, *Macroinvertebrates, *Norway, *Oil pollution, *Recolonization, *Water pollution effects, Colonization, Restoration.

Perturbations of marine sediment may defaunate or disturb patches in soft bottom communities which subsequently are recolonized. Experiments were performed by placing oiled and unoiled defaunated

sediment in boxes (0.2 sq m) on the sea floor in 2 Norwegian fjords, the eutrophicated Oslofjord and the non-eutrophicated Raunefjord. In the Oslofjord no negative effects of the added oil (3920 ppm wet weight sediment) on macrofauna community structure were seen after 3 mo., thus restoration of the community took less than 3 mo during a spring/summer situation in a soft bottom area with a species composition dominated by opportunistic species (Polydora spp.). In the Raunefjord the effect of the added oil (4520 ppm) was shown in reduced species diversity after 4 mo, and altered k-dominance curves, distribution of individuals among species, Hurlbert's rarefaction curves and multidimensional scaling plots. The added oil reduced the mean equilibrium number of species per box from 80 to 55. The time needed to reach 90% of this equilibrium was shorter in the oiled boxes (259 d) than in the control boxes (466 d). Immigration rates were similar (0.27 species/d/box) in both treatments during June to November; however, from November to March the rate was higher in control boxes (0.24) than in oiled boxes (0.17). Mean extinction rates in boxes were; however, larger in the oiled boxes than in the control boxes during both periods. It is concluded that restoration of the benthic macrofauna after oil contamination of sediment takes longer in a non-eutrophicated area than in a eutrophicated area. The reduced density of macrofauna in the oiled boxes in the Raunefjord was caused by toxic response to oil directly, or by secondary effects leading to increased mortality, rather than by reduced settlement. Macrofauna recolonization is easily affected by oil-contamination in a non-eutrophicated area; however, separation of oil-specific responses in benthic communities from responses to other disturbances can hardly be demonstrated without relevant controls. (Author's abstract)
W91-03832

INCREASE OF BENTHIC BIOMASS IN THE SKAGERRAK-KATTEGAT DURING THE 1970S AND 1980S--EFFECTS OF ORGANIC ENRICHMENT.
Groelands Fiskeriundersoegelser, Charlottenlund (Denmark).
A. B. Josefson.
Marine Ecology Progress Series MESEDT, Vol. 66, No. 1/2, p 117-130, September 1990. 6 fig, 4 tab, 35 ref.

Descriptors: *Baltic Sea, *Benthos, *Eutrophication, *Macroinvertebrates, *North Sea, *Skagerrak-Kattegat, *Species diversity, *Water pollution effects, Biomass, Community structure, Echinoderms, Foods, Nutrients, Polychaetes, Salinity.

A benthic data set that illustrates environmental changes over a 16 yr period in a large area of the Skagerrak and northern Kattegat (a transition area between the Baltic Sea and the North Sea) is presented. Biomass and abundance of macrobenthos was monitored from 1972 to 1988 at 14 soft-sediment stations below the halocline in the Skagerrak-Kattegat area. Year-to-year variations in fauna were analyzed. Clear general trends were demonstrated over the study area, which is >170 km long. Total biomasses showed linear increases by a median factor of 1.8, primarily from 1981 to 1988, and biomasses excluding some large species, notably echinoids, increased by a median factor of 1.7 from 1972 to 1988. The changes were primarily due to echinoderms, notably the amphiuroid Amphiura filiformis, and polychaetes. Polychaetes contributed more to the increase at the deepest stations, and the absolute increase of this group was positively related with water depth. The relative increases in biomass without large species as well as biomass of amphiuroids and polychaetes were positively related to water depth. Parallel to the biomass change, land freshwater run-off from western Sweden and to Danish inner waters have increased, and this has influenced the input of nutrients to the sea. Although reliable data on primary production and sedimentation of organic material are largely lacking, the present results are in accordance with hypotheses that soft-sediment infauna in the area is food limited, and that the area is being affected by organic enrichment. (Author's abstract)
W91-03833

DETECTION OF INITIAL EFFECTS OF POLLUTION ON MARINE BENTHOS: AN EXAMPLE FROM THE EKOFISK AND ELDFISK OILFIELDS, NORTH SEA.
Oslo Univ. (Norway). Inst. of Marine Biology.
J. S. Gray, K. R. Clarke, R. M. Warwick, and G. Hobbs.
Marine Ecology Progress Series MESEDT, Vol. 66, No. 3, p 285-299, September 1990. 14 fig, 3 tab, 26 ref.

Descriptors: *Benthic fauna, *Bioindicators, *Norway, *Oil pollution, *Species diversity, *Water pollution effects, Classification, Community structure, Multivariate analysis, Ordination.

The environmental effects of oil fields on marine benthos were studied in the Ekofisk and Eldfisk oil fields in Norway. Exploration of the Ekofisk field began in the late 1960's and the first environmental investigation around the main platform complex was carried out in 1973. Environmental investigations in the adjacent Eldfisk field began in 1984 in conjunction with the fifth survey of the Ekofisk field. This study is based on the results of the sixth environmental survey of the Edofisk field and the second at Eldfisk. Sampling sites were arranged as radii and were approximately logarithmically spaced with 38 sites located at the Edofisk field and 20 at the Eldfisk. Reductions in number of species and diversity and increased dominance of opportunistic species occurred late in the sequence of response to oil as a stress factor (within 500 to 1000 m of discharge sources). However, multivariate analyses, (classification analysis using the Bray-Curtis dissimilarity index) and ordination (multi-dimensional scaling) clearly distinguished site groupings related to oil activities at distances of up to 2 to 3 km from the Ekofisk pollution source and up to 1.5 km from the Eldfisk source. The first recorded changes in benthic communities in response to oil were increased abundance patterns of some species and changes in the presence and absence patterns of rare species, with species being mostly present in one site group and mostly absent in another site group. Only under severe pollution did the opportunistic species, which have often been suggested as universal indicators of pollution, dominate. The major site groupings could still be distinguished after aggregation to higher taxa (families and even phyla) when using multivariate analyses. If these findings prove to be a generally applicable, then great savings in time and effort, with little or no loss of precision, will be possible in environmental monitoring. Although the use of determinations to phyla for monitoring is not yet confirmed, the use of multivariate analyses does appear capable of providing diagnostic monitoring of oil activity effects. (White-Reimer-PTT)
W91-03837

EFFECTS OF CLIMATIC CHANGE ON THE THORNTHWAITE MOISTURE INDEX.
Geological Survey, Trenton, NJ.
For primary bibliographic entry see Field 2B.
W91-03858

PREDICTION, VALIDATION, MONITORING, AND MITIGATION OF ANTHROPOGENIC EFFECTS UPON NATURAL SYSTEMS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
J. Cairns.
Environmental Auditor ENVAE8, Vol. 2, No. 1, p 19-25, 1990. 27 ref.

Descriptors: *Ecological effects, *Environmental effects, *Habitat restoration, *Monitoring, *Water pollution control, Minimization, Model studies, Recycling, Waste disposal, Waste management, Water pollution effects, Water quality control.

Abundant evidence on a global scale shows that the capacity of ecosystems to endure the stresses put upon them by human activities has been exceeded in a variety of ways, and present practices are not suitable for reaping the long-term benefits of natural ecosystems. A global environmental quality control system must be put into place which includes: range finding or screening tests to determine which activities are likely to result in adverse effects upon ecosystems; the development of prediction models that will determine acceptable levels of such uses, if any; the validation of these models in field enclosures of natural systems or surrogates of natural systems (microcosms and mesocosms); and monitoring systems to ensure that previously established quality control systems based on the predictive and validation activities are being met nd to provide an early warning when they are not. Finally, restoration ecology must be used more vigorously to restore the ecosystems damaged by anthropogenic activities so that the ecosystem's services (such as carbon storage) are again available. Ecosystem restoration will mitigate some of the environmental impacts by transforming deleterious materials into less harmful or even beneficial materials, but the primary effort to make long-term, sustainable, beneficial use of ecosystems possible will depend on waste minimization and recycling. Waste minimization means selection of production methods that produce the least harmful waste products (low toxicity, rapid degradation, and small volume) and methods that allow recycling of materials deleterious to the environment or involving high energy demands in their production. Prescriptive laws and regulations should be avoided to ensure the flexibility needed for generating the large database to make the predictive models more robust. (Lantz-PTT)
W91-03871

QUANTIFICATION OF HYDROCHLORIC ACID AND PARTICULATE DEPOSITION RESULTING FROM SPACE SHUTTLE LAUNCHES AT JOHN F. KENNEDY SPACE CENTER, FLORIDA, USA.
Bionetics Corp., Cocoa Beach, FL.
For primary bibliographic entry see Field 5B.
W91-03878

EFFECTS OF CHLORINE DIOXIDE ON THE DEVELOPING RAT BRAIN.
Health Effects Research Lab., Research Triangle Park, NC. Developmental Toxicology Div.
For primary bibliographic entry see Field 5F.
W91-03880

ENVIRONMENTAL ASPECTS OF CRYPTOSPORIDIUM SPECIES: A REVIEW.
Scottish Parasite Diagnostic Lab., Glasgow. Dept. of Bacteriology.
For primary bibliographic entry see Field 5F.
W91-03881

ALTERATIONS IN THE ENERGY METABOLISM OF AN ESTUARINE MYSID (MYSIDOPSIS BAHIA) AS INDICATORS OF STRESS FROM CHRONIC PESTICIDE EXPOSURE.
Environmental Research Lab., Gulf Breeze, FL.
C. L. McKenney, and E. Matthews.
Marine Environmental Research MERSDW, Vol. 30, No. 1, p 1-19, 1990. 5 fig, 4 tab, 51 ref.

Descriptors: *Animal metabolism, *Bioindicators, *Crustaceans, *Estuaries, *Fenthion, *Pesticides, *Water pollution effects, Nitrogen, Organophosphorus pesticides, Oxygen, Stress, Toxicity, Zooplankton.

Dose-response relationships were developed for several metabolic rate functions (oxygen consumption and ammonia excretion) and physiological indices (K2 values and O/N ratios) at different life stages of an estuarine mysid (Mysidopsis bahia) during a life cycle exposure to fenthion, an organophosphate insecticide. Initial exposure to fenthion resulted in elevated respiration rates of juvenile mysids. As shown by lower net growth efficiency (K2 values), these increased metabolic demands reduced the amount of assimilated energy available for production of new tissue, resulting in retarded juvenile growth rates. O/N ratios indicated that juvenile mysids primarily utilized lipid substrates as an energy source, but during maturation shifted to greater usage by proteinaceous substrates. Higher O/N ratios during maturation of fenthion-exposed mysids suggest greater reliance on the

more energy-rich lipid substrates to support the elevated rates of oxidative metabolism, resulting in less lipid material being available for gamete production. These results, when compared with similar studies with two other pesticide classes, suggest that measurements of alterations in the energy metabolism of contaminated individuals from sensitive zooplankton populations (e.g. mysids) may be used as indicators of reductions in population performance from chronic exposure to toxic organics. (Author's abstract)
W91-03883

CHARACTERIZATION AND ASSAY CONDITIONS FOR USE OF ACHE ACTIVITY FROM SEVERAL MARINE SPECIES IN POLLUTION MONITORING.
Institut Francais de Recherche pour l'Exploitation de la Mer, Nantes. Lab. Effets Biologiques des Nuisances.
For primary bibliographic entry see Field 5A.
W91-03885

EFFECTS OF AN OIL SPILL ON THE GASTROPODS OF A TROPICAL INTERTIDAL REEF FLAT.
Smithsonian Tropical Research Inst., Balboa (Panama).
S. D. Garrity, and S. C. Levings.
Marine Environmental Research MERSDW, Vol. 30, No. 2, p 119-153, 1990. 12 fig, 8 tab, 30 ref.

Descriptors: *Gastropods, *Intertidal areas, *Oil spills, *Reefs, *Water pollution effects, Caribbean Sea, Marine environment, Oil pollution, Species diversity, Tropical regions, Water level.

The effects of an oil spill on the mollusks of an intertidal reef flat were examined. At least 8,000,000 L of medium weight crude oil were spilled on 27 April 1986 from the refinery at Isle Payardi on the Caribbean coast of the Republic of Panama. The severity of effects on a nearby reef flat varied with the amount of oil deposited in a green zone of the reef. Immediate mortality of snails occurred in zones with heavy accumulations of oil and abundances further decreased in some zones after the activities of a cleanup crew. Overall density and species number decreased over time. Recruitment appeared reduced in some zones more than two years after the spill. No such patterns were observed at an un-oiled control site until a small spill of diesel fuel in May 1988 similarly reduced mollusk populations. However, this spill had no long-term effects. Effects of oil spills on these types of reef flats depend on the pattern of tidal emersion at the time of the oil spill, because water levels determine the distribution of oiling across the reef flat. (Author's abstract)
W91-03887

ENVIRONMENTAL CONSEQUENCES OF SALINE GROUNDWATER INTRUSION INTO THE WIMMERA RIVER, VICTORIA.
Kaiela Fisheries Research Station, Shepparton (Australia). Fisheries Div.
For primary bibliographic entry see Field 2F.
W91-03898

5D. Waste Treatment Processes

PERFORMANCE OF MODIFIED RECIRCULATING SAND FILTERS USING BOTTOM ASH AND BOILER SLAG MEDIA.
West Virginia Univ., Morgantown. Water Research Inst.
W. A. Sack, M. A. Usmen, and S. P. Dix.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-222266/AS. Price codes: A04 in paper copy, A01 in microfiche. Technical Completion Report of Project WV87-09, 1989. 49p, 1 fig, 15 tab, 24 ref, 2 append. USGS Contract No. 14-08-0001-G1457. USGS Project No. G1457-09.

Descriptors: *Filtration, *Septic wastewater, *Wastewater treatment, Ash, Biochemical oxygen demand, Boiler slag, Design criteria, Nitrogen removal, Performance evaluation, Sand filters.

This research was conducted to evaluate the performance of a novel recirculating sand filter (RSF2) treating septic tank effluent. The RSF2 consisted of a column containing filter media underlain by gravel. The gravel served both as a storage and treatment zone. Effluent was pumped into the bottom of the gravel and recirculated to the top of the filter. Effluent was removed from a layer which lay between the filter media and the gravel zone. Four different RSF2 columns containing: (1) screened boiler slag or Black Beauty (BB); (2) screened Fort Martin Bottom Ash (FMBA); (3) unscreened Fort Martin Bottom Ash (EFMBA); and (4) screened Mitchell Bottom Ash (MBA). Loading rates based on forward flow (FFO of 5 to 10 FPD/cu ft and recirculation ratios (RR) of 3:1 and 5:1 were studied. It was found that all columns could be successfully operated at a FF of 5GPD/sq ft and a RR of 5:1 for long periods without ponding. It was concluded that bottom ashes screened to WV specifications could be operated at a loading rate of 6 GPD/sq ft. However, unscreened bottom ash filters should be restricted to 5 GPD/sq ft. The gravel storage zone functioned well in replacing the normally used recirculation tank. In addition, it served as a treatment device for removal of BOD-5 and total nitrogen (TN). BOD-5 removal is conservatively estimated to range between 20% to 40%. Total nitrogen removal which takes place mainly in the gravel zone ranged from 34% to 59%. Recirculation ratios of 3:1 and 5:1 were compared at a FF of 10 GPD//sq ft. The lower recirculation ratio improved TN removal somewhat, probably due to a more completely anoxic condition in the gravel zone. However, the lower RR also reduced run length before ponding and allowed odor generation. Variation in hydraulic loading rate from 5 to 10 GPD/sq ft produced an effluent below 10 mg/L BOD-5 and SS as long as the filters were not ponded. This suggests that an RSF2 system operated at a FF of 5 to 6 GPD/sq ft could withstand short-term hydraulic overloads without deterioration in effluent quality. (USGS)
W91-02984

WETLANDS AND WASTEWATER MANAGEMENT: QUESTIONS, ANSWERS, ADVICE, AND GUIDANCE.
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 5G.
W91-03014

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR WASTES FROM THE PRODUCTION OF DINITROTOLUENE, TOLUENEDIAMINE, AND TOLUENE DIISOCYANATE, K027, K111, K112, K113, K114, K115, K116, U221, AND U223.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 5G.
W91-03015

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR WASTES FROM THE PRODUCTION OF CHLORINATED ALIPHATIC HYDROCARBONS F024.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 5G.
W91-03016

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR PHTHALATE WASTES.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 5G.
W91-03017

FINAL, BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR K011, K013, AND K014.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 5G.
W91-03018

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT): BACKGROUND DOCUMENT FOR K009 AND K010.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 5G.
W91-03028

WATER USE, REUSE AND ABUSE.
General Development Corp., Miami, FL.
N. Roen, and R. S. Murali.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 5B-13--5B-21, 14 ref.

Descriptors: *Agricultural water, *Florida, *Wastewater renovation, *Water conservation, *Water management, *Water resources management, *Water reuse, *Water use, Cape Coral, Economic aspects, Environmental protection, Political aspects, Water quality control.

The Cape Coral, Florida debate over dual water systems has brought into focus the complex technical, legal, regulatory, political, socio-economic, financial, public health and environmental issues involving the use, reuse and conservation of ground and surface water resources. Serious and irreversible damage can be caused to the resource, economic development and growth management if these factors are not adequately addressed. The paper presents a review of: the current legal and regulatory framework with emphasis on evolving laws with respect to water use and reuse; the impact of political, socioeconomic and public health issues and the technical, environmental and financial constraints on opportunities for wastewater reuse; and specific disincentives in the current approaches to water use and reuse. There is a need to address both conservation and reuse much more rationally and on a broader scale. A broad-based funding mechanism should be established to undertake viable, large-scale conservation and reuse projects which would have a measurable effect on the water resources. In addition, more environmentally acceptable disposal technologies, developing concepts such as 'Casa del Agua' where potable and nonpotable sources are separated, recycled and reused on site, changes in domestic and irrigation practices toward utilizing drought-tolerant species, low-volume irrigation technologies and plumbing residences and commercial and industrial facilities with low-volume fixtures will have significant impact on conservation and reuse. (See also W91-03032) (Lantz-PTT)
W91-03056

WATER-QUALITY VARIABILITY IN A CENTRAL FLORIDA WETLAND RECEIVING HIGHWAY RUNOFF.
Geological Survey, Altamonte Springs, FL.
For primary bibliographic entry see Field 5B.
W91-03058

PROCESSES AFFECTING RETENTION OF WATER-QUALITY CONSTITUENTS IN A DETENTION POND-WETLAND SYSTEM.
Geological Survey, Altamonte Springs, FL.
W. S. Gain, and R. A. Miller.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 7A-13--7A-23, 3 fig, 1 tab, 13 ref.

Descriptors: *Detention reservoirs, *Path of pollutants, *Storm wastewater, *Wastewater treatment, *Water management, *Water quality, *Wetlands treatment, Aluminum oxide, Biodegradation, Chemical precipitation, Florida, Heavy metals, Iron, Monitoring, Orlando, Phosphorus, Sedimentation, Zinc.

A detention pond-wetland stormwater treatment system in Orlando, Florida, was monitored during 11 storms from 1982 to 1984 to evaluate its effect

on stormwater quality. In general, both the pond and the wetland efficiently retain solid phase constituents. However, differences were observed in the efficiencies at which each of the treatment units retain total dissolved solids, lead and zinc. Retention efficiencies for dissolved solids, lead and zinc were low in the pond and high in the wetland. Conversely, retention efficiencies for dissolved phosphorous were low in the wetland and high in the pond. The low retention efficiency for dissolved solids in the pond may reflect a combination of dissolution from bed sediments and limited biological assimilation. The wetland may maintain phosphorous with less efficiency than the pond because the wetland is more biologically active and presumably cycles phosphorous in larger quantities, maintaining higher concentrations between storms than does the pond. The relatively high efficiency at which dissolved phosphorous is retained in the pond may be attributed to one or a combination of the following: net assimilation by plants, adsorption to bottom materials, or precipitation with iron and aluminum oxide. Zinc concentrations in pond sediments may dissolve into pond water between storms, increasing pond water zinc concentrations and decreasing the dissolved zinc retention efficiency of the pond. The greater retention efficiency for zinc in the wetland than the pond may be attributed to lower concentrations of zinc in wetland sediments, greater rates of wetland biological activity that absorb and immobilize zinc, or different oxidation/reduction conditions in wetlands. (See also W91-03032) (Author's abstract)
W91-03059

USE OF A FORESTED WETLAND IN SOUTH CAROLINA FOR TERTIARY TREATMENT OF MUNICIPAL WASTEWATER.
CH2M Hill, Charleston, SC.
D. S. Baughman, R. L. Knight, W. J. Dunn, and L. Schwartz.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 7A-25--7A-37, 5 tab, 14 ref.

Descriptors: *Municipal wastewater, *South Carolina, *Tertiary wastewater treatment, *Wastewater treatment, *Water management, *Water pollution effects, *Wetland wastewater treatment, Biochemical oxygen demand, Groundwater quality, Monitoring, Nitrates, Nitrogen, Phosphorous, Suspended solids, Vegetation, Waccamaw River, Water quality, Wetlands.

The Grand Strand Water and Sewer Authority (GSWSA) began a pilot study in June 1986 with 400,000 gpd of treated wastewater discharged to a forested wetland called Central Slough on the Waccamaw River in Horry County, South Carolina. This pilot study was conducted to test the assimilative capacity of a cypress-gum wetland and to assess the potential biological effects of the wastewater discharge. Two years of operational monitoring of surface and groundwater quality, and biota have been conducted and are summarized in this paper. The effluent discharged to Central Slough had an average biochemical oxygen demand (BOD) of 13 and 19 mg/L in year 1 and year 2, respectively, while ammonia averaged 6.1 and 10.2 mg/L during the same years. As the effluent flowed through the 32-hectare wetland, ultimate oxygen demanding (UOD) constituents were reduced by 90% in year 1 and 84% in year 2. These estimates are equivalent to mass removal rates of 0.15 and 0.20 g/sq m/d in 1986 and 1987. Overall, the wetland provided at least a 70% reduction for BOD, total suspended solids, NH3-N, total nitrogen, and total phosphorous. No changes in water quality in the Waccamaw River downstream of the wetland were observed during this period, and groundwater monitoring indicated no impacts from the discharge of treated wastewater. The vegetation strata were also monitored over the study period with no changes in the canopy, subcanopy, and shrub importance values of the dominant species observed during the two years of treated wastewater discharge. Ground cover changes were limited to an increase in duckweed. (See also W91-03032) (Author's abstract)
W91-03060

NATIONAL EDUCATIONAL PROGRAM IN WASTEWATER TREATMENT FOR SMALL RURAL COMMUNITIES.
Ohio State Univ., Columbus. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W91-03072

BIOTREATMENT: THE USE OF MICROORGANISMS IN THE TREATMENT OF HAZARDOUS MATERIALS AND HAZARDOUS WASTES.
Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. 150p.

Descriptors: *Biodegradation, *Biological wastewater treatment, *Bioremediation, *Hazardous wastes, *Microbial degradation, *Wastewater treatment, *Water pollution treatment, Chlorinated hydrocarbons, Coal tars, Composting, Groundwater pollution, Heavy metals, Soil contamination.

Strategies for the biological treatment of hazardous materials and wastes were considered at the Proceedings of the Second National Conference on Biotreatment in Washington, D.C., held concurrently with Superfund 1989. In situ treatments were presented for contaminated groundwater, landfills, and soils at the field and bench-scale levels. Combined technologies for soil treatment addressed chlorinated hydrocarbon, pesticide, coal tar, and oil spills. Innovative combined technologies included forced aeration composting, air stripping/bioremediation, and ozonation and biological activated carbon treatment. Public perception and government regulations are analyzed for genetically engineered or adapted microorganisms for bioremediation. Other conference papers examined recombinant DNA technologies in marine biodegradation studies. (See W91-03098 thru W91-03116) (Geiger-PTT)
W91-03097

BIODEGRADATION OF CHLORINATED ALIPHATICS BY A METHANOTROPHIC CONSORTIUM IN A BIOLOGICAL REACTOR.
C.A.A. Bioremediation Systems, Boston, MA.
M. C. Leahy, M. Findlay, and S. Fogel.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 3-9, 8 fig, 22 ref. NSF Award ISI-8703753.

Descriptors: *Biodegradation, *Biofilm reactors, *Biological wastewater treatment, *Chlorinated hydrocarbons, *Methane bacteria, *Wastewater treatment, Groundwater pollution, Microbial degradation, Water pollution treatment.

A biological reactor process employing methane-oxidizing bacteria was used to degrade chlorinated aliphatic hydrocarbons in contaminated water. Trichloroethylene and cis-dichloroethylene were rapidly degraded by a methanotrophic consortium in a reactor in the presence of methane which served as the sole source of carbon for the biofilm. The concentration of methane in the reactor had a profound effect on the rate of degradation of trichloroethylene (TCE). Degradation of TCE occurred much faster at lower concentrations of methane. The effect of methane concentration on cis-dichloroethene degradation was much less. This bioreactor will have potential applications in the pretreatment and treatment of wastewater, polluted groundwater and leachate contaminated soils. (See also W91-03097) (Geiger-PTT)
W91-03098

METABOLIC DIVERSITY OF MICROBIAL BTEX DEGRADATION UNDER AEROBIC OR ANOXIC CONDITIONS.
Michigan Univ., Ann Arbor. Medical Center.
R. H. Olsen, J. J. Kukor, and M. D. Mikesell.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 11-14, 4 tab, 9 ref. NIEHS Superfund Research and Education Grant No. ES-04911. EPA Grant R815750-010.

Descriptors: *Aerobic conditions, *Anoxic conditions, *Aquatic bacteria, *Benzenes, *Biodegradation, *Fate of pollutants, *Pseudomonas, *Wastewater treatment, *Water pollution treatment, DNA, Genetic engineering, Microbial degradation, Toluenes, Xylenes.

Bacterial strains were isolated from aquifers contaminated with petroleum products which exhibited degradation of benzene, toluene, ethylbenzene or xylene (B, T, E, or X) under aerobic or anoxic conditions when nitrate is present. These strains showed diversity with regard to the range of substrates degraded as well as the biochemical mechanisms associated with degradation. From one of these strains, a DNA fragment was cloned which enabled a laboratory strain of Pseudomonas aeruginosa to grow on B or T. This recombinant strain and the DNA-source organism both degraded xylenes, but did not grow on xylene suggesting that the substrate range extends beyond that which will support growth and cellular reproduction. (See also W91-03097) (Author's abstract)
W91-03099

REMOVAL OF HEAVY METAL IONS FROM GROUNDWATERS USING AN ALGAL BIOMASS.
Bio-Recovery Systems, Inc., Las Cruces, NM.
For primary bibliographic entry see Field 5G.
W91-03103

BIOLOGICAL CLEANUP OF EXTENSIVE PESTICIDE CONTAMINATION IN SOIL AND GROUNDWATER.
Societe de Chimie Industrielle, Paris (France).
For primary bibliographic entry see Field 5G.
W91-03105

FIELD DEMONSTRATION OF A FORCED AERATION COMPOSTING TREATMENT FOR COAL TAR.
C.A.A. Bioremediation Systems, Boston, MA.
For primary bibliographic entry see Field 5G.
W91-03106

AIR STRIPPING/BIOREMEDIATION OF CHLORINATED HYDROCARBONS AT AN NPL SITE.
ECOVA Corp., Redmond, WA.
For primary bibliographic entry see Field 5G.
W91-03108

FEDERAL REGULATION OF HAZARDOUS WASTE TREATMENT BY GENETICALLY ENGINEERED OR ADAPTED MICROORGANISMS.
Hogan and Hartson, Washington, DC.
E. L. Korwek.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 83-87, 27 ref.

Descriptors: *Biological treatment, *Bioremediation, *Environmental policy, *Genetic engineering, *Genetic pollution, *Hazardous wastes, *Regulations, *Waste treatment, Biodegradation, Toxicity, Water law.

Substantial reporting requirements under the Toxic Substances Control Act (TSCA) are applicable to hazardous waste treatment by genetically engineered or adapted microorganisms as well as by unmodified organisms. Under the 1986 TSCA regulations, organisms would be classified as new on the basis of taxonomic considerations rather than process. Microorganisms formed to contain genetic

material from different genera are considered new except where only well-characterized, non-coding regulatory regions are transferred. In addition the 1986 TSCA regulations require premanufacture notification (PMN) for new microorganisms. To monitor the environmental applications that have the potential to pose significant environmental risks but that are not intergeneric combinations and thus are not subject to PMN review, the 1986 TSCA regulations proposed promulgating Significant New Use Rules requiring Significant New Use Notification (SNUN). SNUN laws require notification of the agency at least 90 days prior to any new non-agricultural use, including hazardous waste treatment, involving environmental release of engineered pathogens. A significant statutory exemption from PMN and SNUN requirements pertains to chemical substances manufactured or processed in small quantities solely for research and development. A new 1989 draft of the 1986 TSCA regulations has the following key principles: (1) contained, commercial research and development uses of any microorganism are not subject to any reporting requirements; (2) all environmental releases of intergeneric organisms are usually either reportable or reviewable; (3) intergeneric, contained microorganisms that are used for commercial applications are subject to reporting; and (4) reporting is potentially required only for commercial releases of altered or naturally occurring organisms. EPA has not yet announced a policy specifically for genetically engineered organisms under the Resource Conservation and Recovery Act. The Comprehensive Environmental Response, Compensation and Liability Act also includes numerous provisions that play a significant role in determining whether biological treatment methods are applied to Superfund sites. (See also W91-03097) (Geiger-PTT)
W91-03110

TREAT NOT A TREATMENT: THE USE OF ENGINEERED BACTERIA TO TURN WASTE INTO FOOD.
Maryland Univ., College Park. Inst. for Philosophy and Public Policy.
M. Sagoff.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 99-107, 24 ref.

Descriptors: *Bioremediation, *Biotechnology, *Ethics, *Genetic engineering, *Public policy, *Waste treatment, Biodegradation, Public opinion, Risk analysis.

The risks posed by novel microorganisms created by genetic engineering for the purposes of bioremediation of hazardous wastes and other biotechnologies are often no greater than the risks posed by naturally occurring mutants. Microorganism created through genetic engineering may pose less of a risk to man and the environment than naturally occurring mutant strains of bacteria because they are usually tested in the laboratory for their toxicity to man and the environment before they are allowed to be used under field conditions. Regulatory review serves to examine the benefits of new genetically engineered materials and gather public opinion on it before its actual use is permitted. Critics of biotechnology often confound evaluations of its uses by introducing ethical and religious objections into their arguments against it. Historically, the pollution of the environment has been viewed as an activity fostered by big corporations which were seen as opposed to the values and rights of the common working populace. However, the integrity of nature and of the global environment represents an issue that now unites in vast political consensus groups and classes in the United States otherwise opposed in interest and ideology. The use of genetically engineered organisms may be made attractive to the public by advertizing the cultural or moral function bacteria perform in transforming wastes back into something natural, i.e., food for plants and animals. Public policy analysts have shown that what the public ultimately demands is that American industry act on moral principles rather than on political or economic expediency, even if the actions industry takes are the same. (See also W91-03097) (Geiger-PTT)
W91-03112

BIODEGRADATION OF XENOBIOTICS BY SPECIFIC BACTERIA: RESEARCH AND APPLICATIONS.
Groningen Rijksuniversiteit (Netherlands). Dept. of Biochemistry.
B. Witholt, D. B. Janssen, and S. Keuning.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 109-117, 5 tab, 52 ref.

Descriptors: *Bacteria, *Biodegradation, *Dehalogenation, *Microbial degradation, *Priority pollutants, *Waste treatment, *Wastewater treatment, Biological wastewater treatment, Chlorinated hydrocarbons, Genetic engineering, Oxidation.

Investigations of the enzymology, genetics, and physiology of the bacterial degradation of xenobiotics should contribute significantly to the development of practical biotreatment. The utilization of a given pollutant by an organism which has the necessary genetic information to express relevant enzymes to degrade the pollutant may be limited by local environmental conditions. Genetic engineering experiments may result in addition bacterial stains capable of degrading priority pollutants. A critical step in the microbial metabolism of chlorinated compounds is dehalogenation. Five dehalogenation mechanisms have been observed in aerobic bacteria. Hydrolytic dehalogenation is well documented for the conversion of 2-halocarboxylic acids by bacteria that utilize chloropropionate or chloroacetate for growth. Some dehalogenases have been isolated and produced in synthetic form. Compounds with vinylic halogens, trihalomethanes, and several other highly chlorinated aliphatics may be degraded by oxidative conversion mediated by monooxygenases produced by methanotrophic bacteria. Pollutants that are not presently biodegradable may be recalcitrant due to lack of necessary bacterial enzymes to utilize the pollutant, or accumulation of toxic intermediates which inhibit degrading microorganisms. An important goal of research on the biodegradation of chlorinated hydrocarbons will be to achieve biological removal of chlorinated hydrocarbons by microorganisms that rely on cometabolic conversion. Anaerobic conversions that cause dechlorination have been described for several highly chlorinated compounds, such as carbon tetrachloride, perchloroethylene, and 1,1,1-trichloroethane. These conversions could become very important for removing chlorinated aliphatics at low redox potential in anaerobic subsurface environments. (See also W91-03097) (Geiger-PTT)
W91-03113

GENETIC ENGINEERING APPROACH TO TREATING ORGANOPHOSPHATE WASTES.
Maryland Univ. Baltimore County, Catonsville. Dept. of Chemical and Biochemical Engineering.
G. F. Payne, S. J. Coppella, N. DelaCruz, M. K. Speedie, and B. M. Pogell.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 129-133, 2 fig, 2 tab, 39 ref.

Descriptors: *Biodegradation, *Enzymes, *Genetic engineering, *Organic wastes, *Organophosphorus pesticides, *Wastewater treatment, Fermentation, Hazardous wastes, Hydrolysis, Parathion.

Under certain conditions, toxic wastes may be appropriately treated using enzyme-based processes. Since enzyme-based treatment strategies do not require the release into the environment of viable organisms but only cell-free preparations, it is possible to consider the use of recombinant technologies for enzyme production. A recombinant Streptomyces which produces and excretes an enzyme capable of hydrolyzing organophosphates was developed by genetic engineering. By optimizing and scaling up the fermentation, large quantities of this parathion hydrolase enzyme have been produced. This enzyme is currently being tested for its ability to hydrolyze organophosphate pesticides under real and simulated waste conditions. Initial laboratory results indicated that a crude enzyme preparation obtained from the fermentations was capable of hydrolyzing coumaphos in actual waste liquid. The use of enzymes to treat soil contaminated with organophosphates is also a potential use. (See also W91-03097) (Author's abstract)
W91-03115

BIODEGRADATION OF AN OILY BILGE WASTE USING ALGAE.
GHR Engineering Associates, Inc., Lakeville, MA.
For primary bibliographic entry see Field 5G.
W91-03116

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR CYANIDE WASTES.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 5G.
W91-03219

1988 NEEDS SURVEY REPORT TO CONGRESS: ASSESSMENT OF NEEDED PUBLICLY OWNED WASTEWATER TREATMENT FACILITIES IN THE UNITED STATES.
Environmental Protection Agency, Washington, DC. Office of Municipal Pollution Control.
For primary bibliographic entry see Field 6B.
W91-03232

COST AND TECHNOLOGY DOCUMENT ON DRINKING WATER TREATMENT FOR INORGANIC WASTES--WASTE DISPOSAL.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-192363. Price codes: A11 in paper copy, A01 in microfiche. September 1986. 88 fig, 39 tab, 36 ref, 5 append.

Descriptors: *Administrative regulations, *Drinking water, *Sludge disposal, *Waste disposal, *Waste management, *Wastewater treatment, *Water treatment, Brine disposal, Cost analysis, Inorganic compounds, Waste characteristics, Wastewater management, Water quality standards.

The United States Environmental Protection Agency (EPA) is in the process of revising the National Interim Primary Drinking Water Regulations. EPA has identified a number of inorganic, radionuclide, and corrosion-related contaminants for which allowable maximum contaminant levels (MCL) in drinking water may be established. Waste disposal options and associated costs have been evaluated for water treatment processes removing many of these contaminants. Waste by-products generally are divided into two categories: sludges and brines. The most economical disposal method for sludges was discharge to the sanitary sewer followed closely by drying lagoons/beds with land disposal. Direct land application for lime softening sludges also was a lower cost alternative. The most economical disposal method for brines was either direct discharge or sanitary sewer discharge. Another lower cost alternative was evaporation pond dewatering and land disposal. Total costs increased in proportion to system complexity and the required amount of equipment. For both sludges and brines, large systems have low total costs because of economies of scale while total costs for small systems are very high. The optimum waste treatment and disposal alternative will be affected by regulatory constraints (industrial pretreatment requirements for sanitary sewer discharges; the RECRA requirements for hazardous waste disposal) and site-specific conditions (cli-

mate, availability of sanitary sewers or suitable receiving water, cost of land, location of disposal sites). (Fish-PTT)
W91-03233

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR ORGANOPHOSPHORUS WASTES.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 5G.
W91-03236

CONTROL TECHNOLOGY ASSESSMENT REPORT FOR AIR EMISSIONS FROM WASTEWATER TREATMENT OPERATIONS.
Research Triangle Inst., Research Triangle Park, NC.
S. Harkins, and A. S. Damle.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-207922. Price codes: A03 in paper copy, A01 in microfiche. Report no. EPA-450/3-89-008, April 1989. 35 p, 1 fig, 5 tab, 6 ref, append. Contract no. 68-02-4397.

Descriptors: *Air pollution control, *Air pollution sources, *Chlorinated hydrocarbons, *Waste management, *Wastewater treatment, Carbon filters, Cost-benefit analysis, Refrigeration, Ventilation, Volatile organic compounds, West Virginia.

The Occidental Chemical Plant at Belle, West Virginia, produces chlorinated solvents (e.g., methylene chloride, carbon tetrachloride, and chloroform). The wastewater treatment operations at this plant result in substantial air emissions with a high concentration of volatile organic compounds (VOCs). Field information gathered in September 1986 and July 1988 was used to estimate the total annual emissions of the VOCs as well as the maximum rate of emissions due to working losses from the wastewater treatment operations. Condensation of organics in a refrigeration system, carbon adsorption and a combination of both techniques were evaluated as possible air emissions control options. Based upon this study, the following conclusions may be drawn for efficient organics removal from wastewater treatment system vent VOC emissions at the plant: (1) connecting the headspaces of storage feedwater tank and decanter tanks will eliminate the source of VOC emissions at the feedwater tank; (2) for any control system to be effective, a forced drive system such as a fan at the downstream of the control system is essential; (3) it is necessary to prevent any unwarranted vapor emissions; (4) the secondary vent condenser is capable of condensing up to 68% by mass of vapors in the feed stream using refrigerated glycol cooling; and (5) a combination of the refrigerated glycol cooled secondary condenser and a subsequent carbon adsorption system will be able to remove almost all of the organics in the emissions at a lower cost than that for a carbon adsorption system alone. (Fish-PTT)
W91-03237

RECOVERY OF METALS USING ALUMINUM DISPLACEMENT.
Circuit Chemistry Corp., Maple Plain, MN.
S. C. Meyers.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-222590. Price codes: A03 in paper copy, A01 in microfiche. Report, June 1988. 27 p, 9 fig, 2 tab, 3 append.

Descriptors: *Ion exchange, *Metal-finishing wastes, *Metals, *Recycling, *Waste management, *Waste recovery, *Wastewater treatment, Aluminum, Copper, Lead, Nickel, Tin, Waste treatment, Wastewater reactors, Water pollution prevention.

The removal of typical metals (copper, lead, tin, nickel) from printed circuit and metal finishing waste streams was evaluated using displacement with aluminum. The metal is recovered as metal particles, is nonhazardous, and can be recycled by smelting. The results of this project indicate that aluminum exchange systems could become a significant choice of waste treatment technology for printed circuit manufacturers. Copper, lead, and tin were removed at 85 percent and higher efficiencies from the majority of printed circuit waste streams using a single pass through the aluminum exchange reactor. A multiple pass system using either recirculation through a single reactor, or exchange reactors in series, with the proper flow rate should produce compliance with regulated discharge standards in many facilities. The low equipment cost and simplicity of operation are positive attributes. The aluminum exchange equipment system must be properly engineered for each unique facility to assure good results. For efficient use of this technology, the waste streams should be segregated into metal-containing and non-metal-containing streams. The amounts of flow in the metal-containing streams should be minimal by the use of rinses. The resulting low volume waste stream with high metal concentrations up to 200 ppm is very suitable for aluminum exchange. The low volume flow provides the retention time required for efficient displacement. Waste streams containing nitrates were not successful. Nickel-containing waste streams produced no displacement on aluminum. (Fish-PTT)
W91-03239

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR K043.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 5G.
W91-03241

WATER RECLAMATION: HERE, NOW...AND HOW.
Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. 132p. Edited by Benton C. Price.

Descriptors: *Conservation, *Reclaimed water, *Wastewater treatment, *Water reuse, *Water treatment, Drought, Public policy, Resources management, Waste disposal, Wastewater utilization, Water supply.

Today, California's water supplies, like many others nationwide, are threatened by drought. Without adequate water, public landscapes, golf courses, parks, nurseries, industry and agriculture will suffer dramatic losses. Water reuse started in California in 1889. Raw sewage was used to irrigate and fertilize the vast sand dunes on the western edge of San Francisco. Since 1928 the California State constitution has prohibited waste or unreasonable use of water, encouraging the reuse of water wherever safe and practical. The nation's first water reclamation treatment plant was built in San Francisco in 1932. Prudent water users, whose interests have been rekindled by the drought, are recognizing the value of water reuse and are moving to secure such supplies. By including water reclamation in the overall water supply and management program, water supplies are extended, wastewater disposal costs are reduced, water quality is improved, energy is saved, and user rates are stabilized. The Association of Water Reclamation Agencies' (AWRA) annual Water Reuse Symposium represents a forum in which to hear and discuss current water reuse issues, share project successes, explore political, regulatory and cost issues, tour exemplary facilities, and meet people who move the industry. (See W91-03274 thru W91-03289) (Agostine-PTT)
W91-03273

CONTRA COSTA WATER RECLAMATION PROJECT.
Central Contra Costa County Sanitary District, Martinez, CA.
R. Dolan.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 5-10.

Descriptors: *California, *Reclaimed water, *Wastewater treatment, *Wastewater utilization, *Water reuse, *Water treatment, Drinking water, Legal aspects, Water policy, Water resources institutes, Water resources management.

The Contra Costa Reclamation Project is a joint effort of the Contra Costa Water District and the Central Contra Costa Sanitary District (Central San). The water district serves 36 million gallons per day to about 185,000 people. Agricultural demand is now down to 4 million gallons per day. The reclamation project conceived by the engineers for the two districts was a 17 to 30 million-gallon-per-day, low-nitrogen, low-phosphorus reclaimed water project which would supply reclaimed water to five industries. The Central San plant simply couldn't meet its design intent when it went into operation. While in the process of repairing and completing the plant, a number of other things happened in the water reclamation field. California's Title 22 health regulations came into effect. Basin plan requirements came into being which affected both Central San and industrial customers. The state implemented laws and regulations promoting maximum use of reclaimed water. In 1986, Central San and the water district started Phase I of a multiphase evaluation of the water reclaim projects. It was concluded that the economic feasibility of the reclamation projects had been improved by virtue of the increased cost of drinking water. Two reuse options were identified as technically and economically feasible: industrial cooling and landscape irrigation on the order of 5 million gallons a day. In order to proceed with the industrial project and be prepared to pump reclaimed water that next year, a demonstration project was developed. The 1-million-gallon-per-day demonstration project currently operating, is meeting Title 22; it is filtering, nitrifying to take out ammonia and softening. The results of the engineering study will be available in the Spring of 1989. At that time the water district, the sanitary district and the industries will meet to evaluate the future of the reclamation projects. (See also W91-03273) (Agostine-PTT)
W91-03274

PLANNING FOR WATER RECLAMATION IN SOUTHERN CALIFORNIA.
Irvine Ranch Water District, CA.
For primary bibliographic entry see Field 3D.
W91-03275

WHAT COMMUNITY LEADERS HAVE TO DO TO MAKE RECLAMATION HAPPEN.
San Diego County Water Authority, CA.
For primary bibliographic entry see Field 6E.
W91-03276

REGULATIONS THAT ENCOURAGE RECLAMATION.
For primary bibliographic entry see Field 6E.
W91-03277

STATE LEGISLATURE'S VIEW OF RECLAMATION.
For primary bibliographic entry see Field 6E.
W91-03278

RISK MANAGEMENT.
Environmental Protection Agency, San Francisco, CA. Region IX.
J. C. Wise.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 41-50.

Descriptors: *Reclaimed water, *Risk assessment, *Wastewater treatment, *Water reuse, *Water treatment, Drinking water, Legislation, Public opinion, Toxic wastes, Water resources management.

An important aspect of water reclamation that engineering and marketing pragmatism may not be able to overcome is the fundamental issue of how to gain public acceptance of reclaimed water and public trust in the way that water supplies are managed. Industry professionals know that reclamation operations can be derived from wastewaters, return flows, process waters, and even contaminated groundwaters. Those in the industry worry about such things as pathogens, nutrients, metals and organics. The general public does not concern itself with such technical details. Simply stated the public perception of reclaimed water is 'toxic substances in drinking water'. There is a need to better understand the public fear of toxic substances. Three fundamental features of this fear phenomenon are considered. The first feature is the significance of the word 'toxins'. Public fear of chemicals is a powerful and compelling presence in California. The second feature of the toxic substances issue is the 'community right-to-know'. This was recently enacted into law by Title 3 of the 1986 Superfund Amendments and Reauthorization Act at the federal level. The new regulations pursuant to Proposition 65 in California require warning notices and disclosures. The third feature of this issue is the reality that toxins are everywhere. The public seems to be demanding a risk-free environment, or at least an environment free of involuntary risks. The approach of environmental risk management has some promise in reconciling these public fears. Risk management is a matter of choices, explicitly made, based upon a full consideration of all the facts and all of the values. Choice is another word for control. By involving people and especially local leaders in the risk assessment/risk management process, we are seeking to mitigate fears and to reestablish some measure of control. When people see how these decisions are made and see that they have some control over them, they know when to be afraid and when to calm down. Control, therefore, fights panic. (See also W91-03273) (Agostine-PTT)
W91-03279

SOME THOUGHTS ON SECONDARY EFFLUENT.
California Univ., Davis. Dept. of Civil Engineering.
G. Tchobanoglous.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 51-53.

Descriptors: *Filters, *Reclaimed water, *Secondary wastewater, *Wastewater treatment, *Water reuse, *Water treatment, Physical properties, Sludge, Suspended solids, Turbidity.

Five filters used in wastewater reclamation were studied to determine the performance characteristics. Title 22 requirements were used to evaluate the various filters. The types of filters studied were: (1) a mono-medium pulsed-bed filter, (2) a dual-medium filter, (3) a mono-medium deep-bed filter, (4) a continuous upflow filter, and (5) a pair of traveling-bridge filters. What differentiates these filters is the method that is used for the temporary storage of solids. In the pulsed-bed filter, pulsing is used to accumulate material in the upper layers of the filter. In the dual medium and mono-medium filters the interstices of the sand and anthracite grains are used for solid storage. In the upflow filter continuous backwash is employed. In the traveling bridge, surface management is used with a continuous backwash. The parameters investigated include turbidity, suspended solids, and particle size. With respect to turbidity and suspended solids, it was found that each unit of turbidity corresponds to approximately 2.3 to 2.4 mg/L of suspended solids. This relationship has also been found at other installations with activated sludge. Thus, turbidity can be used as a surrogate measure of suspended solids. If the effluent turbidity is less than about 10 to 12 nephelometric turbidity units (NTU), all of the filters tested will produce an average effluent turbidity of 2 NTU or less without the addition of chemicals. If the effluent turbidity is greater than 10 to 12 NTU, all of the filters tested will require chemical addition to achieve an effluent turbidity of 2 NTU or less. (See also W91-03273) (Agostine-PTT)
W91-03280

COST OF WASTEWATER RECLAMATION.
HYA Consulting Engineers, Arcadia, CA.
For primary bibliographic entry see Field 6C.
W91-03281

FINANCING RECLAMATION PROJECTS.
South Coast Water District, Laguna Beach, CA.
For primary bibliographic entry see Field 6C.
W91-03282

HOW TO GET THE PUBLIC BEHIND WATER RECLAMATION.
Los Angeles County Sanitation District, CA.
For primary bibliographic entry see Field 6B.
W91-03283

WATER QUALITY REQUIREMENTS FOR WATER REUSE.
California Regional Water Quality Control Board, San Diego. San Diego Region.
L. H. Delaney.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 93-98.

Descriptors: *California, *Reclaimed water, *Wastewater treatment, *Water quality, *Water quality standards, *Water reuse, *Water treatment, Coasts, Coliforms, Legal aspects, Legislation, Ocean dumping, Public opinion, Wastewater facilities, Water quality management.

The California health department has a specific set of health related criteria for every type of water use. There is a trend in Region IX in California of dischargers selecting the very highest health criteria, which is the nonrestricted recreational impoundment standard. Key features of this criteria includes a coliform standard of 2.2 most probable number (mpn) per 100 mL, and treatment that requires oxidation, coagulation, clarification, and filtration. There are three current factors driving the move toward water reuse: (1) 301(h) waivers, (2) coastal treatment plant capacity, and (3) drought. The 301(h) waivers would have allowed for reducing the treatment levels for ocean discharge. The demise of the waivers drives the cost of ocean discharge up to at least secondary treatment levels, and therefore, the cost difference between ocean disposal and reclamation is much less. Many coastal treatment plants are operating at or near capacity. There is strong public opposition to the expansion of coastal treatment plants. Finally there is a real water shortage in southern California which will drive the need for water reuse. (See also W91-03273) (Agostine-PTT)
W91-03284

HEALTH CRITERIA FOR WATER REUSE.
California Dept. of Health Services, San Bernardino. Public Water Supply Branch.
D. L. Barich.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 99-105.

Descriptors: *California, *Public health, *Reclaimed water, *Wastewater treatment, *Water quality, *Water quality standards, *Water reuse, *Water treatment, Bacteria, Coagulation, Effluents, Enteroviruses, Filtration, Giardia, Irrigation, Legal aspects, Legislation, Microorganisms, Oxidation process, Pathogens, Primary wastewater treatment, Salmonella, Secondary wastewater treatment, Tertiary wastewater treatment, Viruses, Wastewater disposal, Water quality management.

In 1968 the California State Department of Health Service (DHS) issued the first set of regulations under the title 'Statewide Standards for the Safe Direct Use of Reclaimed Water for Irrigation and Impoundments'. The criteria, found in Title 22 of the California Code of Regulations, have undergone a number of revisions and are currently being reviewed. The criteria define: (1) the reclaimed water quality required for the degree of public exposure; (2) The required degree of treatment for the degree of exposure; and (3) the reliability features required for the assurance of a safe product. Some of the pathogens that can be found in wastewater are Giardia lamblia, salmonella and the enteroviruses that cause intestinal upsets. These disease-causing microorganisms can survive for very long times in soil, water and on vegetables. The criteria are therefore intentionally restrictive to satisfy that portion of the criteria that requires 'assured positive health protection.' The degrees of sewage treatment defined include: (1) primary treatment consisting of sedimentation; (2) secondary treatment consisting of oxidation and disinfection; and (3) tertiary treatment consisting of oxidation, coagulation, clarification, filtration, and disinfection. There are provisions for the development of alternative treatment trains that, after extensive independent evaluation, have proven to be reliably equivalent. Each alternative must be approved by the DHS. Reliability features include alarms to indicate failure of treatment, such as chlorine residual and turbidity alarms; emergency storage or disposal facilities for inadequately treated effluent; and duplicate treatment facilities to prevent bypass of vital treatment steps during repairs and maintenance. (See also W91-03273) (Agostine-PTT)
W91-03285

WATER REUSE PLANS AND ASSISTANCE PROGRAMS.
San Diego County Water Authority, CA.
For primary bibliographic entry see Field 6B.
W91-03286

IRRIGATING SOD FARMS WITH RECLAIMED WATER.
For primary bibliographic entry see Field 3C.
W91-03287

GOLF COURSE IRRIGATION WITH RECLAIMED WATER.
Moulton Niguel Water District, Laguna Niguel, CA.
For primary bibliographic entry see Field 3C.
W91-03288

FREEWAY LANDSCAPE IRRIGATION IN SAN DIEGO COUNTY.
For primary bibliographic entry see Field 3C.
W91-03289

SOLID-PHASE EXTRACTION FOR TOXICITY REDUCTION EVALUATIONS OF INDUSTRIAL WASTEWATER EFFLUENTS.
West Point-Pepperell Research Center, Valley, AL.
M. J. M. Wells, A. J. Rossano, and E. C. Roberts.
Analytica Chimica Acta ACACAM, Vol. 236, No. 1, p 131-139, September 1990. 1 fig, 1 tab, 45 ref.

Descriptors: *Bioassay, *Industrial wastewater, *Separation techniques, *Toxicity, *Wastewater analysis, *Wastewater treatment, *Water analysis, Daphnia, Effluent limitations, Monitoring, Water pollution effects.

The physical, chemical and biological characteristics of industrial and municipal wastewater effluents in the United States are limited in National Pollutant Discharge Elimination System (NPDES) permits. Toxicity reduction evaluations involving fractionation of wastewater effluents, biomonitoring for aquatic toxicity and determinations of specific chemicals are conducted when adverse effects on water quality are detected during routine biomonitoring as required by the NPDES permit. However, certain fractionation techniques are incompatible with subsequent testing for aquatic toxicity. The effect of various schemes for fractionation of wastewater effluent on biomonitoring with

freshwater Cladocerans (Daphnia magna, Daphnia pulex, Ceriodaphnia dubia or Ceriodaphnia reticulata) is reviewed. In both liquid-liquid or solid-phase extraction, the extract is recovered in an organic solvent that may be toxic to the test organisms. another problem experienced during fractionation by liquid-liquid extraction is that the extraction solvent may dissolve in the aqueous portion (i.e., the wastewater). In most of the fractionation schemes, toxicity testing is performed on reconstituted extract. When the fractionation is conducted by frontal chromatography, suspect toxicants are removed from the solution prior to toxicity testing. Additional treatments such as removal of solids, molecular weight/size fractionations, chelation of cations, oxidant reduction and variation of water hardness are also used in toxicity reduction evaluation. (Geiger-PTT)
W91-03291

KINETIC AND ECONOMIC CONSIDERATIONS OF BIOGAS PRODUCTION SYSTEMS.
Bangladesh Agricultural Univ., Mymensingh. Dept. of Farm Power and Machinery.
B. K. Bala, and M. A. Satter.
Biological Wastes BIWAED, Vol. 34, No. 1, p 21-38, 1990. 9 fig, 2 tab, 14 ref.

Descriptors: *Biogas, *Economic aspects, *Kinetics, *Model studies, *Waste treatment, Bangladesh, Cost-benefit analysis, Developing countries, Energy sources, Fermentation, Mathematical models, Volatile solids.

The kinetics and economics of substrate degradation and biogas production are considered through the mass balance on substrate, with either the Contois or Adams-Eckenfelder model. These models were used to design the mathematical models of volatile solids reduction and biogas fermentation. The predictions of both the models were found to be in close agreement with the observed values reported. A computer model based on a system dynamics approach was used to model the economics of biogas production by anaerobic digestion from cattle slurry available from typical rural families in Bangladesh. This model incorporated the Adams-Eckenfelder model to determine the amount of gas production, and a technique previously described to take into account the effects of price, interest, and inflation. The production of biogas from anaerobic digestion of cattle slurry for cooking is not economic in terms of return when compared with the cost of fuel wood. However, assigning values to the treated slurry as a fertilizer, and to pollution hazards, would improve the economics. The annual cost was minimum for 15 days of retention time with a daily loading of the slurry from 2 or 4 cows. However, the cost was least for a 20 day retention time for 6 or 8 cows, the cost is reduced considerably when the number of cows is increased to > 4. Fuel wood is currently being collected mainly from rural forests in Bangladesh and being used at an extremely high rate. Biogas shows a potential in saving fuel wood and reducing ecological imbalances. However, relatively large reductions in the digester cost factor or increases in the price for fuel are required for biogas production to be economic in terms of returns. (Lantz-PTT)
W91-03385

IMPACT OF ANIMAL WASTE LAGOONS ON GROUND-WATER QUALITY.
Delaware Agriculture Experiment Station, Newark.
For primary bibliographic entry see Field 5B.
W91-03386

EFFECTS OF USING VARIOUS TYPES OF CARBONACEOUS SUBSTRATE ON UASB GRANULES AND ON REACTOR PERFORMANCE.
Birmingham Univ. (England). Dept. of Civil Engineering.
J. W. Morgan, J. A. S. Goodwin, D. A. J. Wase, and C. F. Forster.
Biological Wastes BIWAED, Vol. 34, No. 1, p 55-71, 1990. 10 fig, 6 tab, 17 ref.

Descriptors: *Carbon, *Sludge digestion, *Wastewater reactors, *Wastewater treatment, Acetates, Ammonia, Biomass, Butanol, Casein, Comparison studies, Ice cream, Lipids, Nitrogen, Performance evaluation, Sludge treatment, Sucrose.

A set of 10 upflow anaerobic sludge blanket (UA3B) digesters was examined as five pairs--one control and four test pairs--to assess the way in which selected types of carbonaceous substrate affected the performance of the reactors. The carbon sources were sucrose, acetate, casein, butanol and ice cream. The results show that the change of feed caused a deterioration in the performance of all the test digesters. The casein feed caused the greatest impact, with de-amination of the protein producing inhibitory levels of ammoniacal nitrogen. This suggests that the use of unacclimatized sludges, even granular sludges, to treat proteinaceous wastes might give unsatisfactory results. It is, therefore, not unreasonable to suppose that there might be the same type of behavior with any wastewater that produced metabolic products which could cause stress to the biomass. The feed that was based on ice cream produced a low specific gas yield because of the way in which one of its components (thought possibly to be lipid) accumulated on the biomass. Care should, therefore, be taken in applying UASB technology, using unacclimatized granules, to wastewaters containing significant concentrations of lipids or other refractory compounds. (Lantz-PTT)
W91-03387

CITRIC ACID PRODUCTION IN LIQUID WASTE FROM A LEAF-PROTEIN PRODUCTION PLANT: EFFECTS OF SUGAR AND POTASSIUM FERROCYANIDE.
Indian Statistical Inst., Calcutta. Leaf Protein Research Unit.
For primary bibliographic entry see Field 5E.
W91-03388

REMOVAL OF TRACE LEVELS OF AROMATIC AMINES FROM AQUEOUS SOLUTION BY FOAM FLOTATION.
Trevecca Nazarene Coll., Nashville, TN. Dept. of Science and Mathematics.
G. A. Nyssen, J. S. White, P. Bibring, and D. J. Wilson.
Separation Science and Technology SSTEDS, Vol. 25, No. 7/8, p 809-824, June/July 1990. 16 fig, 1 tab, 10 ref.

Descriptors: *Amines, *Aromatic compounds, *Flotation, *Foam separation, *Wastewater treatment, Aminobiphenyl, Aminonaphthalene, Benzidine, Benzylamine, Chemical treatment, Dyes, Hydrogen ion concentration, Pyridine, Sodium dodecylsulfate, Surfactants, Xylidine.

Aromatic amines, including 4-(t-butyl)pyridine, 4-(n-butyl)aniline, benzylamine, 4-aminobiphenyl, 1-, and 2-aminonaphthalene, and 2,6-xylidine, were effectively removed from water by foam flotation with the anionic surfactant sodium dodecylsulfate (SDS). With initial amine concentrations of 10 mg/L or less, residual amine concentrations of < 0.1 mg/L were generally obtained after 10-30 minutes of flotation. The SDS concentration and flotation time are directly related to the amount of amine removed. Amine removal is most efficient at pH values low enough so that the amine is protonated (usually about 3), and at low ionic strength. Alcohols up to 10% by volume do not appreciably affect amine removal. The mechanism of removal is dominated by ion-ion attraction between the surfactant and the protonated amine; there is also apparently some contribution from ion-dipole attraction. Benzidine is not removed effectively; evidently it is insufficiently hydrophobic. Foam flotation appears to be a promising technique for the removal of aromatic amines and other organic bases from wastewater; it may prove adaptable to the treatment of sludges and soils as well. (Author's abstract)
W91-03389

ESTIMATION OF THE BIOCHEMICAL OXYGEN DEMAND FROM POLLUTION PARAMETERS IN A WASTE DISPOSAL SYSTEM FOR DAIRY PROCESSING WASTES.
Louisiana Agricultural Experiment Station, Baton Rouge.
R. H. Gough, S. C. Baick, R. W. Adkinson, and J. J. Ryan.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 6, p 679-685, August 1990. 2 tab, 5 ref.

Descriptors: *Aerated lagoons, *Biochemical oxygen demand, *Food-processing wastes, *Wastewater analysis, *Wastewater lagoons, *Wastewater treatment, Chemical oxygen demand, Dairy industry, Louisiana, Model studies, Pollution index, Regression analysis, Solids, Suspended solids, Wastewater facilities.

Biochemical oxygen demand (BOD) was estimated from other pollution parameters in a diary plant processing wastewater. The wastewater treatment system, located at a Louisiana dairy processing facility, consisted of three mechanically aerated lagoons with earth embankments and side slopes. Wastewater samples were randomly collected in the first and second lagoons and final effluent was obtained from the third lagoon. Samples were analyzed for BOD, chemical oxygen demand (COD), total suspended solids (TSS), and total solids (TS). Stepwise regression analysis was used to derive a prediction model for BOD based upon TSS, TS, and COD. In a comparison of the actual and predicted BOD values for 18 wastewater samples, only one observation fell outside the 95% confidence interval. It is concluded that BOD values could be reliably predicted using the model. The ability to predict BOD from other pollution parameters would enable daily checking of the wastewater treatment system, rather than waiting 5 days for a result. (MacKeen-PTT)
W91-03538

WASTE TREATMENT BY REVERSE OSMOSIS AND MEMBRANE PROCESSES: INDUSTRIAL (NOV 76-OCT 89). CITATIONS FROM THE COMPENDEX DATABASE.
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 10C.
W91-03568

WASTEWATER AND WATER TREATMENT: ANION EXCHANGE (JAN 77-MAY 89). CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE.
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 10C.
W91-03570

EFFLUENT TREATMENT IN THE PAINT AND COATING INDUSTRY (JAN 80-MAY 89). CITATIONS FROM THE WORLD SURFACE COATINGS ABSTRACTS DATABASE.
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 10C.
W91-03571

EFFLUENT TREATMENT IN THE TEXTILE INDUSTRY: DYES (JAN 83-JUN 89). CITATIONS FROM THE WORLD TEXTILE ABSTRACTS DATABASE.
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 10C.
W91-03572

ANIMAL WASTE POLLUTION AND ITS CONTROL (JAN 70-JUN 89). CITATIONS FROM THE NTIS BIBLIOGRAPHIC DATABASE.
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 10C.
W91-03573

TOXICITY REDUCTION EVALUATION FOR MUNICIPAL WASTEWATER TREATMENT PLANTS.
Engineering-Science, Fairfax, VA.
J. A. Botts, J. W. Braswell, J. Zyman, W. L. Goodfellow, and S. B. Moore.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-195218/AS. Price codes: AO5 in paper copy, AO1 in microfiche. Report No. EPA/600/2-88/062. April 1989. 77p, 6 fig, 10 tab, 47 ref, 2 append.

Descriptors: *Municipal wastewater, *Toxicity, *Wastewater facilities, *Wastewater treatment, Effluent toxicity, Protocols, Toxicity reduction evaluations.

A generalized protocol for conducting a Toxicity Reduction Evaluation (TRE) at a municipal wastewater treatment plant (WWTP) is presented. This protocol is designed to provide guidance to municipalities in preparing TRE plans, evaluating the information generated during TREs, and developing a technical basis for the selection and implementation of toxicity control methods. A TRE involves an evaluation of the municipal WWTP performance; an identification of the specific toxicants causing effluent toxicity; a review of the pretreatment and local limits programs; a characterization of the nature, variability and sources of toxicity; and the evaluation, selection and implementation of the toxicity control options. Because of the broad scope of this protocol, it is to be expected that site specific considerations may to some extent warrant modifications and tailoring of the protocol approach for a given facility. The protocol has been developed based on current research and experience. TRE methods and procedures will be updated and refined based on the results of ongoing research and case studies. (Author's abstract)
W91-03582

EFFLUENT FEES: POLICY CONSIDERATIONS ON A SOURCE OF REVENUE FOR INFRASTRUCTURE FINANCING.
Yale Univ., New Haven, CT. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 5G.
W91-03592

COMPARISON OF FALLING-FILM AND GLASS-TUBE SOLAR PHOTOCATALYTIC REACTORS FOR DESTROYING TOXIC ORGANIC CHEMICALS IN WATER.
Sandia National Labs., Albuquerque, NM. Solar Thermal Collector Technology Div.
For primary bibliographic entry see Field 5F.
W91-03595

DEVELOPMENT AND EVALUATION OF A RUBBER 'DUCK BILL' TIDE GATE.
Freeman (Peter A.) and Associates, Inc., Berlin, MD.
For primary bibliographic entry see Field 8A.
W91-03603

BENEFITS OF TARP TO THE ILLINOIS RIVER.
Illinois State Water Survey Div., Champaign.
K. P. Singh, T. A. Butts, and A. Durgunoglu.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 69-76, 3 fig, 2 tab, 6 ref.

Descriptors: *Chicago, *Combined sewer overflows, *Flow control, *Illinois, *Wastewater treatment, Evaluation, Flood control, Illinois River, Management planning, Rainfall-runoff relationships, Water quality, Water resources management, Water treatment.

The Chicago Tunnel and Reservoir Plan (TARP) was conceived to eliminate combined sewer overflows to the Metropolitan Water Reclamation District of Greater Chicago waterways, by storing the runoff from rainfall in underground tunnels and reservoirs, and then gradually releasing it through the existing wastewater treatment plants. The benefits of TARP have been considered for the project area, which covers about 375 sq miles; however, the propagation of these benefits to the Illinois Waterway downstream of Lockport to its confluence with the Mississippi River has not yet been investigated. A study is in progress to determine the reduction in peak flow and improvement in water quality with TARP Phase 1 (nearing completion) and Phase 2 (which includes reservoirs), and to investigate the propagation of these effects downstream of Lockport to Meredosia. The reduced peak flows and stages will provide some relief from severe flooding, thus reducing flood damages and posing less danger to the levees along the river. Runoff from the urban Chicago area, about 375 sq miles, will be treated at the wastewater plants before it is released to the waterways. This will lead to significant improvement in water quality in the Illinois River. (See also W91-03608) (Author's abstract)
W91-03617

WASTEWATER IRRIGATION IN DEVELOPING COUNTRIES: HEALTH EFFECTS AND TECHNICAL SOLUTIONS.
Hebrew Univ. of Jerusalem (Israel). School of Public Health.
For primary bibliographic entry see Field 3F.
W91-03650

CONDITIONABILITY, FILTERABILITY, SETTLEABILITY AND SOLIDS CONTENT OF SLUDGES 1984 (A COMPENDIUM OF METHODS AND TESTS): METHODS FOR THE EXAMINATION OF WATERS AND ASSOCIATED MATERIALS.
Available from Her Majesty's Stationery Office, Government Bookshops, London, England. 54p, 11 fig, 2 tab, 15 ref.

Descriptors: *Analytical methods, *Data acquisition, *Laboratory methods, *Sludge solids, *Sludge treatment, *Wastewater treatment, Activated sludge process, Chemical treatment, Sludge cake, Sludge conditioning, Sludge thickening, Suspended solids.

Methods are included for the: determination of the total solids content (dry residue at 105 C) and the loss on ignition of dry residue at 550 C of sewage and waterworks sludges and related solids; determination of the suspended solids content of sewage and waterworks sludge and related solids; determination of the filterability of a sludge using the capillary suction time (CST) method; determination of the conditionability of a sewage and waterworks sludge; initiation selection of chemicals for use as settlement aids in the treatment of wastewaters; determination of the thickening characteristics of sludges using a low-speed centrifuge method; determination of the settleability of activated sludge expressed as the stirred specific volume index (SSVI) or stirred sludge density (SSD); and, measurement of the specific resistance to dewatering of a sludge, and the sludge cake compressibility coefficient. (Lantz-PTT)
W91-03662

EQUITY AND EFFICIENCY ASPECTS OF ALTERNATE STORMWATER MANAGEMENT FINANCING SYSTEMS.
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
For primary bibliographic entry see Field 5G.
W91-03714

WETLANDS: A FUTURE NONPOINT POLLUTION CONTROL TECHNOLOGY.
Wetlands Research, Inc., Chicago, IL.
For primary bibliographic entry see Field 5G.
W91-03729

WATER QUALITY PERFORMANCE OF A DETENTION BASIN-WETLAND TREATMENT SYSTEM IN AN URBAN AREA.
Metropolitan Council, St. Paul, MN.
For primary bibliographic entry see Field 5G.
W91-03730

5E. Ultimate Disposal Of Wastes

DISCHARGE WATER QUALITY OF PERMITTED WET DETENTION SYSTEMS.
Southwest Florida Water Management District, Brooksville.
For primary bibliographic entry see Field 5G.
W91-03061

MANAGEMENT ALTERNATIVES FOR CHANNEL A, A FLOOD BYPASS CANAL.
Brown and Caldwell, Tampa, FL.
K. W. Boyer, and P. A. Clark.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 12A-5--12A-17, 3 fig, 3 Tab, 13 ref.

Descriptors: *Bypass channels, *Flood routing, *Florida, *Wastewater disposal, *Water management, *Wetlands, Estuaries, Field tests, Flood control, Surface water, Water quality, Wetland restoration.

Management alternatives for improving water quality in a man-made bypass canal are presented in light of a local utility's plan to increase point source discharges of highly treated domestic wastewater. In 1987, the Florida legislature enacted the Grizzle-Figg bill which presumes discharges of recovered water meeting advanced wastewater treatment (AWT) standards will have minimal impact on selected bays and tributaries located in southwest Florida. As a preferred alternative to discharging to relatively pristine surface waters, local utilities are planning to discharge recovered water to a flood bypass canal. Current operation of the flood control system does not consider water quality in Channel A. Alternatives to improve water quality in Channel A, by augmenting streamflow both upstream and downstream of its salinity barrier are recommended as part of a surface water management program for the Rocky Creek drainage basin. Implementation is recommended to begin with field testing followed by an engineering evaluation using locally accepted water quality models leading to a preliminary design and cost estimate. Selected alternatives should also compliment habitat restoration work in Upper (Old) Tampa Bay. Using recovered water to supplement dry-weather freshwater inflows to estuarine marshes is recommended to simulate groundwater exfiltration spread uniformly along the upland shoreline. A linear drain field, spray irrigation or recharge wells in areas immediately upland of the marsh would supplement groundwater exfiltration to the marsh. (See also W91-03032) (Lantz-PTT)
W91-03077

WATER RESOURCES MANAGEMENT IN A SMALL CENTRAL FLORIDA COMMUNITY: TAVARES, FLORIDA.
Howard, Needles, Tammen, and Bergendoff, Orlando, FL.
For primary bibliographic entry see Field 5G.
W91-03078

FIELD DEMONSTRATION OF A FORCED AERATION COMPOSTING TREATMENT FOR COAL TAR.
C.A.A. Bioremediation Systems, Boston, MA.
For primary bibliographic entry see Field 5G.
W91-03106

FEDERAL REGULATION OF HAZARDOUS WASTE TREATMENT BY GENETICALLY ENGINEERED OR ADAPTED MICROORGANISMS.
Hogan and Hartson, Washington, DC.
For primary bibliographic entry see Field 5D.
W91-03110

TREAT NOT A TREATMENT: THE USE OF ENGINEERED BACTERIA TO TURN WASTE INTO FOOD.
Maryland Univ., College Park. Inst. for Philosophy and Public Policy.
For primary bibliographic entry see Field 5D.
W91-03112

3-D STOCHASTIC DISCRETE FRACTURE NETWORK MODEL FOR SIMULATING FLOW AND TRANSPORT THROUGH FRACTURED MEDIA.
Ecole Nationale Superieure des Mines de Paris, Fontainebleau (France). Centre d'Information Geologique.
For primary bibliographic entry see Field 2F.
W91-03190

COST AND TECHNOLOGY DOCUMENT ON DRINKING WATER TREATMENT FOR INORGANIC WASTES--WASTE DISPOSAL.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
For primary bibliographic entry see Field 5D.
W91-03233

WASTE MANAGEMENT SCHEMES OF POTASH MINES IN SASKATCHEWAN.
Manitoba Hydro, Winnipeg.
For primary bibliographic entry see Field 5G.
W91-03304

DISPOSAL OF RADIUM FROM DRINKING WATER TREATMENT.
Wisconsin Dept. of Natural Resources, Madison. Public Water Supply Section.
N. Hahn.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 249-267. 12 tab, 14 ref.

Descriptors: *Drinking water, *Radioactive waste disposal, *Radioactive wastes, *Radioisotopes, *Radium, *Waste disposal, *Wastewater facilities, *Water treatment, *Water treatment wastes, Economic aspects, Political aspects, Public health, Regulations, Risks.

Waste containing radium removed by sodium ion exchange water treatment plants (WTP) and wastewater treatment plants (WWTP) is identified as naturally occurring radioactive material (NORM). The disposal of WTP and WWTP solid and liquid wastes containing concentrated amounts of radium is feasible in most cases. Each system will face unique disposal circumstances requiring a case-by-case review by design engineers and regulatory agencies. Because radium removal treatment concentrates the radium, it is important that disposal methods protect human health and the environment. Radium removal processes that create wastes that can be practically disposed of will likely be selected over processes that create more highly radioactive wastes. The impact on NORM waste disposal from the mandated opening of additional low-level radioactive waste disposal facilities in the 1990's remains unclear at this time. Additional research is needed on the concentrations of radionuclides contained in NORM wastes and the environmental impacts on their disposal. State regulatory agencies and water and wastewater utilities need to evaluate the fate of radium through treatment processes and take steps to properly dispose of NORM waste. (See also W91-03366) (Agostine-PTT)
W91-03382

PUBLIC ACCEPTANCE STRATEGIES FOR SLUDGE UTILIZATION.
Charlotte-Mecklenburg Utility Dept., NC.
T. C. Mendenhall.
Biocycle BCYCDK, Vol. 31, No. 10, p 34-37, October 1990.

Descriptors: *Land disposal, *North Carolina, *Public relations, *Sludge disposal, *Sludge utilization, Agriculture, Charlotte, Marketing, Public participation, Wastewater disposal.

Wastewater treatment and drinking water are provided for 400,000 people in Charlotte (North Carolina), Mecklenburg County, and two other adjoining counties by a single utility, the Charlotte-Mecklenburg Utility Department (CMUD). Among the challenges facing CMUD is sewage sludge--what to do with it, how to handle it, and its ultimate disposal. CMUD generates approximately 38 dry tons (or 186 cu yd) daily of anaerobically digested sludge at five wastewater treatment facilities. Previously, CMUD sold its sludge to the general public for a nominal fee. That practice was prohibited by the State of North Carolina in 1983. Local landfilling was the disposal option until the State Division of Health Services halted this practice for the county in 1984. In 1985, CMUD sought cost effective and environmentally safe disposal options for sludge. Land application was chosen since the program could be put into operation in a reasonably short time without capital expense. CMUD quickly learned that the key to a successful program was public acceptance. Managing the program requires constant selling, reselling, and explaining to outsiders, top management, public officials, elected officials, farmers, the farmers' neighbors, and a number of other such affected parties. The first step taken by CMUD was to withdraw its application for sites in a bordering county. The state permitted a few sites in Mecklenburg County, and the district began a very limited land application program in October 1987. This enabled CMUD to establish the safety of the practice. A field demonstration was arranged for officials of the neighboring county. While the majority of the county commissioners were not ready to approve the proposal, they decided it was time to resolve the issue and scheduled an official public hearing in early 1988. When the hearing was held, there was no opposition, and the political representatives voted to accept the program on a 2-year trial basis. To this day CMUD maintains a very active presence in the neighboring county by participating in activities such as 'Agriculture Appreciation Week'. (Lantz-PTT)
W91-03383

PUBLIC HEALTH AND SLUDGE UTILIZATION: PART II.
Agricultural Research Service, Beltsville, MD. Soil-Microbial System Lab.
For primary bibliographic entry see Field 5B.
W91-03384

CITRIC ACID PRODUCTION IN LIQUID WASTE FROM A LEAF-PROTEIN PRODUCTION PLANT: EFFECTS OF SUGAR AND POTASSIUM FERROCYANIDE.
Indian Statistical Inst., Calcutta. Leaf Protein Research Unit.
S. Chanda, S. Chakrabarti, and S. Matai.
Biological Wastes BIWAED, Vol. 34, No. 1, p 77-81, 1990. 4 tab, 14 ref.

Descriptors: *Culture media, *Fermentation, *Industrial wastewater, *Potassium ferrocyanide, *Sugars, *Waste disposal, *Wastewater treatment, *Wastewater utilization, Biochemical oxygen demand, Chemical oxygen demand, Chemical precipitation, Chemical treatment, Molasses, Turnips, Waste treatment, Whey.

The liquid waste from a leaf-protein plant ('whey') has posed serious problems for disposal due to its high COD and BOD values. Because it contains carbohydrates, amino acids, minerals, vitamins and other growth factors, it may be utilized for growth of industrially important microbes. Citric acid production by Aspergillis niger was studied in whey along with the effects of sugar and potassium ferrocyanide (K4Fe(CN)6) additions to the culture medium; it has been reported that K4Fe(CN)6 reduces the inhibitory effects of some metal ions. A turnip medium was found to be better for citric acid production than beet whey. Therefore, turnip whey was further fortified with molasses, and molasses-turnip whey was further treated with K4Fe(CN)6 at different concentrations. The molasses-turnip whey treated with K4Fe(CN)6 (0.06% w/v) gave increased yields. K4Fe(CN)6 may remove (by precipitation) some elements known to interfere with citric acid production; this precipitation favors the production of citric acid in many molasses-supplemented media. From these results, it is evident that utilizing wheys as a production medium for citric acid may solve the disposal problem of wheys on the one hand while, on the other hand, utilization of two biological wastes (molasses and whey) simultaneously, with a mere addition of K4Fe(CN)6, may bring an economical method to the field of industrial fermentation. (Lantz-PTT)
W91-03388

CONTRACTORS, INJECTION WELLS, AND THE TC RULE.
National Water Well Association, Worthington, OH.
For primary bibliographic entry see Field 5G.
W91-03391

CASE-CONTROL STUDY OF THE IMPACT OF IMPROVED SANITATION ON DIARRHOEA MORBIDITY IN LESOTHO.
Overseas Development Inst., London (England).
D. L. Daniels, S. N. Cousens, L. N. Makoae, and R. G. Feachem.
Bulletin of the World Health Organization BWHOA6, Vol. 68, No. 4, p 455-463, 1990. 1 fig, 5 tab, 17 ref.

Descriptors: *Diarrhea, *Environmental sanitation, *Lesotho, *Morbidity, *Public health, *Sanitation, Comparison studies, Domestic water, Education, Health aspects, Rural Sanitation Pilot Project, Rural areas.

A health impact evaluation of the Rural Sanitation Pilot Project in Mohale's Hoek district, Lesotho, was conducted from October 1987 to September 1988. A clinic-based case control design was used to investigate the impact of improved sanitation on diarrhea morbidity in young children. The results indicate that under-5-year-olds from households with a latrine may experience 24% fewer episodes of diarrhea than such children from households without a latrine. The impact of latrines on diarrhea was greater in those households that used more water, practiced better personal hygiene, and where the mothers had a higher level of education or worked outside the home. In common with studies conducted in Malawi, Philippines, and Sri Lanka, little evidence was found that the relationship between latrine ownership and diarrhea was confounded by socioeconomic status or environmental variables. For a sample of cases and controls, data on exposure status (presence or absence of a latrine) that were collected by interview at the clinics agreed closely with those obtained by observation during a home visit. (Author's abstract)
W91-03475

ACCUMULATION OF METALS AND THEIR TOXICITY IN THE MARINE INTERTIDAL INVERTEBRATES CERASTODERMA EDULE, MACOMA BALTHICA, ARENICOLA MARINA EXPOSED TO PULVERISED FUEL ASH IN MESOCOSMS.
Kema N.V., Arnhem (Netherlands). Dept. of Environmental Research.
For primary bibliographic entry see Field 5C.
W91-03481

AIR PERMEABILITY MEASUREMENTS OF THE UNSATURATED BANDELIER TUFF NEAR LOS ALAMOS, NEW MEXICO.
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 2G.
W91-03550

EVALUATION OF THE HYDROGEOLOGIC SYSTEM IN DISPOSAL OF MIXED WASTES.
Argonne National Lab., IL.
Y. P. Chia, Y. C. Yuan, and C. Yu.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-009824. Report No. CONF-890207--23, 1989 11p, 4 fig, 1 tab, 9 ref. DOE Contract W-31-109-ENG-38.

Descriptors: *Geohydrology, *Site selection, *Soil water, *Waste disposal, Groundwater movement, Hydraulic conductivity, Infiltration, Leachates, Leakage, Path of pollutants.

Geohydrologic settings and processes are considered to have a controlling effect on the long-term performance of a multi-layered mixed-waste disposal cell. A conceptual modeling of disposal cells indicated that the hydraulic conductivity of the final cover, compared to that of the liner, plays an equal or more important role in determining both the leakage rate from the unit and the breakthrough time. A low water saturation for the disposal facility or a periodic dry condition at the surface can significantly impede downward water infiltration. Analysis also revealed that the emplacement of a disposal cell may cause the water table to shift upward and possibly saturate part of the disposal cell. Seasonal fluctuation of the water table may then carry leachate away from the waste to the aquifer. Therefore, effective design, construction, and monitoring of a mixed waste disposal cell relies on a comprehensive understandings of infiltration through the land disposal unit and of local hydrogeologic conditions. (Author's abstract)
W91-03594

UPWARD MIGRATION OF UNDERGROUND INJECTION WASTES THROUGH HYDROLOGIC CONDUITS AROUND THE WELLBORE.
Argonne National Lab., IL. Energy and Environmental Systems Div.
Y. Chia, and J. Chiu.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-005839. Price codes: A03 in paper copy, A01 in microfiche. Report No. CONF-8806169--2, 1988. 23p, 6 fig, 1 tab, 9 ref. DOE Contract W-31-109-ENG-38.

Descriptors: *Groundwater pollution, *Hazardous wastes, *Injection wells, *Path of pollutants, *Waste disposal, *Waste disposal wells, Drilling, Fractures, Human health, Hydrologic conduits, Upward migration.

Underground injection, compared to other waste disposal methods, is believed to have the advantage of isolating wastes in a confined brine aquifer well below the horizon of human activity and underground sources of drinking water (USDWs). Recent estimates indicate that of all hazardous waste disposed, more than 60% was injected underground. While most of injected wastes move laterally in the injection zone, posing a long-term concern to human health and the environment, a small amount can migrate upward to the upper aquifers, causing a greater threat to the quality of USDWs. Vertical migration of injected wastes through improperly abandoned wells and fractures in the confining formations is a well-known cause of contamination in shallow USDWs. In addition, wastes can migrate upward through vertical hydrologic conduits around the well. These conduits include microannuli and channels in the cement sheath resulting from poor well completion practices and the deterioration of cement, and fractures in the disturbed zone due to drilling. Both dual porosity and single porosity models were used to investigate the migration of injected wastes through these hydrologic conduits. The results indicate that regional upward migration through an extensive confining formation is a slow process. Nevertheless, injected wastes can move upward rapidly through microannuli and channels in the cement sheath and spread over a distance in the upper aquifer. The wastes can also migrate rapidly through fractures in the disturbed cement and disturbed zone can be significantly diluted if one or more permeable strata exist between the injection zone and USDWs. It was concluded that a critical assessment of upward contaminant migration through hydrologic conduits around the wellbore is essential to ensure the feasibility of underground injection operations. (Author's abstract)
W91-03606

WATER AND THE ENVIRONMENT: THE IMPLEMENTATION OF EUROPEAN COMMUNITY DIRECTIVES ON POLLUTION CAUSED BY CERTAIN DANGEROUS SUBSTANCES DISCHARGED INTO THE AQUATIC ENVIRONMENT.
Department of the Environment, Cardiff (Wales). Welsh Office.
For primary bibliographic entry see Field 5G.
W91-03661

5F. Water Treatment and Quality Alteration

INFORMATION COLLECTION REQUEST FOR: PROPOSED NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR SYNTHETIC ORGANIC CHEMICALS.
Miller (Wade) Associates, Inc., Arlington, VA.
For primary bibliographic entry see Field 5G.
W91-03019

REGULATORY IMPACT ANALYSIS OF PROPOSED NATIONAL PRIMARY DRINKING WATER FOR SYNTHETIC ORGANIC CHEMICALS.
Miller (Wade) Associates, Inc., Arlington, VA.
For primary bibliographic entry see Field 5G.
W91-03020

REGULATORY IMPACT ANALYSIS: BENEFITS AND COSTS OF PROPOSED NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR INORGANIC CHEMICALS.
Miller (Wade) Associates, Inc., Arlington, VA.
For primary bibliographic entry see Field 5G.
W91-03021

TECHNOLOGIES AND COSTS FOR THE REMOVAL OF SYNTHETIC ORGANIC CHEMICALS FROM POTABLE WATER SUPPLIES.
Environmental Protection Agency, Washington, DC. Criteria and Standards Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-192504. Price codes: A16 in paper copy, A01 in microfiche. March 1989. 356p, 28 fig, 48 tab, 7 append.

Descriptors: *Potable water, *Synthetic organic compounds, *Water treatment, Activated carbon, Economic aspects, Organic compounds, Water pollution treatment, Water quality.

EPA is establishing maximum contaminant levels (MCLs) for a number of synthetic organic chemicals (SOCs) which might occur in contaminated water supplies. The purpose of the document is to assist EPA in defining 'best available technology' BAT technology for removing SOCs from water supplies. The treatment and compliance methods available to a community searching for the most economical and effective means to comply with the proposed SOC MCLs include: modification of existing treatment systems, installation of new systems, and the use of nontreatment alternatives such as regionalization or alternate raw water sources. The major factors that must be considered in selecting a compliance method include: (1) quality and type of water source; (2) degree of SOC contamination; (3) specific compound(s) present in water source; (4) economies of scale and the economic stability of the community being served; and (5) treatment and waste disposal requirements. This document provides an evaluation of the various treatment methods in use today for the removal of different concentrations of SOCs, and their relative costs. These methods include: activated carbon, aeration, reverse osmosis, oxidation, coagulation, sedimentation, and filtration. The various studies reviewed indicate that all 29 studied SOCs (with the exception of epichlorohydrin) to be regulated under Phase II can be removed by GAC. The economy of the process is dependent on the carbon usage rate. Certain volatile organics and chlorinated aromatics have relatively poor adsorbabilities, which result in higher carbon usage rates. (Lantz-PTT)
W91-03029

INTERBASIN WATER TRANSFERS: A MANAGEMENT APPROACH FOR PHOENIX'S WATER FUTURE.
Montgomery (James M.) Consulting Engineers, Inc., Pasadena, CA.
For primary bibliographic entry see Field 6A.
W91-03085

AIR STRIPPING/BIOREMEDIATION OF CHLORINATED HYDROCARBONS AT AN NPL SITE.
ECOVA Corp., Redmond, WA.
For primary bibliographic entry see Field 5G.
W91-03108

APPLICATION OF OZONE AND BAC TO CONTAMINATED GROUNDWATER.
Missouri Univ.-Rolla. Dept. of Civil Engineering.
L. G. Cocquyt, and P. K. TerKonda.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 75-81, 9 fig, 2 tab, 8 ref.

Descriptors: *Activated carbon, *Biodegradation, *Ozonation, *Phenols, *Water treatment, Bioremediation, Cleanup procedures, Groundwater pollution, Microbial degradation.

Biological activated carbon (BAC) is a viable way to remove organics from contaminated groundwater. The feasibility of applying BAC to groundwaters with phenol was examined using granular activated carbon and BAC with or without preozonation. Without ozonation BAC was found to treat 17 times more numbers of pore volumes (PV) than GAC in the complete removal of phenol from a contaminated groundwater until breakthrough occurred at 12 PV with GAC. BAC with preozonation was shown to process the contaminated groundwater five times longer than GAC with preozonation to effect 100% removal of phenol until breakthrough occurred at 42 PV with GAC. (See also W91-03097) (Author's abstract)
W91-03109

COST AND TECHNOLOGY DOCUMENT ON DRINKING WATER TREATMENT FOR LOW RANGE COSTS: ESTIMATED LOW RANGE COSTS FOR THE REMOVAL OF INORGANICS, RADIONUCLIDES, AND CORROSION RELATED CONTAMINANTS FROM POTABLE WATER SUPPLIES.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-192355. Price codes: A03 in paper copy, A01 in microfiche. January 1987. 46 p, 6 fig, 6 tab.

Descriptors: *Drinking water, *Economic evaluation, *Water quality, *Water treatment, *Water treatment facilities, Computer models, Corrosion, Cost-benefit analysis, Estimated costs, Inorganic compounds, Radioisotopes, Water supply.

Low-range costs were estimated for the removal of inorganics, radionuclides, and corrosion-related contaminants from potable water supplies. Capital and operating costs for all technologies were developed for ground and surface waters, for 12 system size categories ranging in population from 25 to >1,000,000, depending on which water source the contaminant is generally found. For the purpose of developing these costs, small water systems are defined as those with design flow requirements less than 1.0 mgd. Small systems often have large ratios of system design capacity to average daily flow. At the same time, however, they generally satisfy that demand through a combination of treatment capacity and storage capacity. For the large systems (those greater than 1.0 mgd) capital costs are based on plant design capacities, and for all system sizes operating costs are based on average plant flows. For each contaminant, the influent/effluent combinations which were utilized to develop estimated costs are used

to categorize each group of cost tables for each contaminant, along with the percent removal associated with each combination and the removal efficiency of each process. The capital and operating costs for the technologies developed were determined using an updated computer model written for the U.S. Environmental Protection Agency. For all the technologies considered, designs and unit costs should be viewed as preliminary. More complete and detailed designs and cost estimates should be developed based upon pilot-plant testing and site-specific considerations. (Fish-PTT)
W91-03221

DEVELOPING A STATE WELLHEAD PROTECTION PROGRAM: A USER'S GUIDE TO ASSIST STATE AGENCIES UNDER THE SAFE DRINKING WATER ACT.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
P. Bailey, J. Bendall, V. Pye, A. Barnsdale, and T. Mierzwa.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-173751. Price codes: A03 in paper copy, A01 in microfiche. Report no. EPA 440/6-88-003, July 1988. 44 p, append.

Descriptors: *Drinking water, *Groundwater management, *Legal aspects, *Regulations, *Safe Drinking Water Act, *Water pollution prevention, *Water quality control, *Water supply, Environmental protection, Groundwater pollution, State jurisdiction, Water pollution control.

The 1986 Amendments to the Safe Drinking Water Act (SDWA) established a new Wellhead Protection (WHP) Program to protect groundwaters that supply wells and wellfields that contribute drinking water to public water supply systems. Each state must prepare a WHP program and submit it to EPA by June 19, 1989. A Technical Assistance Document (TAD) has been prepared by EPA to assist states in developing their WHP programs. At a minimum, each state's WHP program must: specify roles and duties of government agencies, delineate the wellhead protection area (WHPA) for each wellhead, identify sources of contaminants within each WHPA, develop management approaches, develop contingency plans, site new wells properly, and ensure public participation. The TAD also provides graphic illustrations that show a range of optional approaches a state might consider in developing the program element; and case study examples that illustrate how a state might address the element in its WHP program. (Fish-PTT)
W91-03222

HETEROTROPHIC PLATE COUNT BACTERIA IN POTABLE WATER MONITORING METHODS AND APPLICATIONS.
Environmental Protection Agency, Cincinnati, OH. Microbiological Treatment Branch.
D. J. Reasoner.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-223697. Price codes: A04 in paper copy, A01 in microfiche. Report no. EPA/600/D-89/072, 1989. 61 p, 1 fig, 3 tab, 73 ref.

Descriptors: *Bacterial analysis, *Drinking water, *Heterotrophic bacteria, *Laboratory methods, *Potable water, *Water analysis, *Water quality, Biofilms, Culturing techniques, Public health, Water treatment.

Measurements of bacterial populations in water have been used since the beginning of sanitary bacteriology, and interest in the interpretation of the results has occupied many researchers over the intervening years. The heterotrophic plate count (HPC), formerly known as the standard plate count, is a useful tool for enumerating bacteria in potable water. Methodology considerations in the selection of the HPC procedure to be used include medium (high or low nutrient), incubation time, incubation temperature, and method (pour plate, spread plate, or membrane filter). Applications of HPC monitoring include evaluation of treatment processes, storage and distribution water quality changes, biofilm development, growth of bacteria on construction materials and microbial corrosion. The application of methods to detect viable but nonculturable organisms in drinking water and the assessment of the importance of these organisms to human health are areas which need to be investigated. (Fish-PTT)
W91-03224

DRINKING WATER HEALTH DOCUMENT ON STYRENE.
Environmental Protection Agency, Cincinnati, OH. Office of Drinking Water.
For primary bibliographic entry see Field 5G.
W91-03230

ECONOMIC IMPACT STUDY OF PROPOSED AMENDMENTS TO ILLINOIS ADMINISTRATIVE CODE 604.203 AND 605.104 OF SUBTITLE F PUBLIC WATER SUPPLIES (TRIHALOMETHANES) R84-12.
Blaser, Zeni and Co., Springfield, IL.
For primary bibliographic entry see Field 6E.
W91-03231

COST AND TECHNOLOGY DOCUMENT ON DRINKING WATER TREATMENT FOR INORGANIC WASTES--WASTE DISPOSAL.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
For primary bibliographic entry see Field 5D.
W91-03233

REGULATORY IMPACT ANALYSIS: BENEFITS AND COSTS OF FINAL SURFACE WATER TREATMENT RULE.
Miller (Wade) Associates, Inc., Arlington, VA.
B. Rourke, and C. Kessler.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-207872. Price codes: A04 in paper copy, A01 in microfiche. 17 February 1989. 71 p, 5 fig, 14 tab. Contract no. 68-03-3514.

Descriptors: *Administrative regulations, *Biological pollution, *Cost-benefit analysis, *Surface water, *Water treatment, Disinfection, Monitoring, Performance evaluation, Potable water, Public health, Turbidity.

The costs and benefits of controlling microbiological contaminants in public water systems using surface water sources have been analyzed using the criteria specified in the final Surface Water Treatment Rule (SWTR). The total national cost of the proposed SWTR consists of six components, as follows: (1) treatment requirements for unfiltered systems; (2) turbidity performance requirements for filtered systems; (3) disinfection performance requirements for filtered systems; (4) treatment requirements for surface-influenced groundwater systems; (5) monitoring requirements; and (6) state regulatory program implementation costs. The incremental cost computed for the final rule ranges from $3.2 to $5.0 billion in capital cost with the annualized cost for capital and O&M equalling $499 to $709 million per year, amortized at a social discount rate of 3 percent. When the 'total' cost of the final rule is computed, the annualized cost is projected to range from $518 to $728 million per year. Microbial contaminants of surface waters are responsible for a number of forms of waterborne disease. When these microorganisms are able to survive the treatment process, waterborne disease may be manifest in two forms: outbreak events and endemic incidence. An important benefit that will accrue from the SWTR requirements is the elimination of waterborne disease outbreaks in surface water systems, and their associated social costs. (Fish-PTT)
W91-03235

WATER RECLAMATION: HERE, NOW...AND HOW.
For primary bibliographic entry see Field 5D.
W91-03273

CONTRA COSTA WATER RECLAMATION PROJECT.
Central Contra Costa County Sanitary District, Martinez, CA.
For primary bibliographic entry see Field 5D.
W91-03274

PLANNING FOR WATER RECLAMATION IN SOUTHERN CALIFORNIA.
Irvine Ranch Water District, CA.
For primary bibliographic entry see Field 3D.
W91-03275

WHAT COMMUNITY LEADERS HAVE TO DO TO MAKE RECLAMATION HAPPEN.
San Diego County Water Authority, CA.
For primary bibliographic entry see Field 6E.
W91-03276

REGULATIONS THAT ENCOURAGE RECLAMATION.
For primary bibliographic entry see Field 6E.
W91-03277

STATE LEGISLATURE'S VIEW OF RECLAMATION.
For primary bibliographic entry see Field 6E.
W91-03278

RISK MANAGEMENT.
Environmental Protection Agency, San Francisco, CA. Region IX.
For primary bibliographic entry see Field 5D.
W91-03279

SOME THOUGHTS ON SECONDARY EFFLUENT.
California Univ., Davis. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-03280

COST OF WASTEWATER RECLAMATION.
HYA Consulting Engineers, Arcadia, CA.
For primary bibliographic entry see Field 6C.
W91-03281

FINANCING RECLAMATION PROJECTS.
South Coast Water District, Laguna Beach, CA.
For primary bibliographic entry see Field 6C.
W91-03282

HOW TO GET THE PUBLIC BEHIND WATER RECLAMATION.
Los Angeles County Sanitation District, CA.
For primary bibliographic entry see Field 6B.
W91-03283

WATER QUALITY REQUIREMENTS FOR WATER REUSE.
California Regional Water Quality Control Board, San Diego. San Diego Region.
For primary bibliographic entry see Field 5D.
W91-03284

HEALTH CRITERIA FOR WATER REUSE.
California Dept. of Health Services, San Bernardino. Public Water Supply Branch.
For primary bibliographic entry see Field 5D.
W91-03285

WATER REUSE PLANS AND ASSISTANCE PROGRAMS.
San Diego County Water Authority, CA.
For primary bibliographic entry see Field 6B.
W91-03286

NUMERICAL MODELING OF PRESSURE-REDUCING VALVES IN WATER DISTRIBUTION NETWORK SYSTEMS.
Lakehead Univ., Thunder Bay (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8C.
W91-03305

WATER TREATMENT TECHNOLOGY FOR REMOVAL OF EXCESS FLUORIDE.
National Environmental Engineering Research Inst., Nagpur (India).
W. G. Nawlakhe, and K. R. Bulusu.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 815-828, 4 fig, 3 tab, 3 ref.

Descriptors: *Developing countries, *Drinking water, *Fluoride removal, *Water treatment, Defluoridation, India, Nalgonda Technique, Performance evaluation, Rural areas, Social aspects, Village water supply.

Removal of excess fluoride from drinking water is necessary to prevent fluorosis in those consuming the water. The National Environment Engineering Research Institute (Nagpur, India) has developed an inexpensive and simple technique for defluoridation called the Nalgonda Technique. The technique is easily adapted by villagers and can be used at the domestic or community levels. The defluoridation operations are performed on a fill-and-draw basis or on a continuous operation basis. Domestic defluoridation can be performed in a bucket. A small hand-operated fill-and-draw unit of 200 L capacity for domestic use has been designed that can be easily operated and maintained by villagers. A similar unit has been designed for a population of 200 villagers. A plant for a small community comprises a hopper-bottom cylindrical tank with a depth of 2 m equipped with a hand-operated or power driven stirring mechanism. Notable features include: (1) completion of defluoridation within 2-3 hr; (2) few needed accessories; (3) no need to shelter either the plant or the motor; and (4) semi-skilled labor can perform the operation without supervision. It has been estimated that to scale up this type of system for a population 2000 (water supply need of 80 cu m/day), the annual per capita cost for running the defluoridation system would 27.17 rupees. (See also W91-03311) (Rochester-PTT)
W91-03344

RADON, RADIUM AND URANIUM IN DRINKING WATER.
Lewis Publishers, Inc., Chelsea, Michigan. 1990. 286p. Edited by C. Richard Cothern, and Paul A. Rebers.

Descriptors: *Drinking water, *Radioisotopes, *Radium, *Radon, *Uranium, *Water quality management, *Water treatment, Public health, Risk assessment, Water quality standards.

This volume covers all aspects concerning radionuclides in drinking water. The primary focus is on the naturally occurring radionuclides, primarily radon, radium, and uranium. The specific topic areas covered include occurrence, mechanisms resulting in human exposure, analytical chemistry, health effects, quantitative risk assessment, treatment technology for the removal of radionuclides, waste disposal, economics, policy and some aspects of enforcement. It is written for the regional, state, and local health officials who need to understand the background information involved in complying with the regulations for radionuclides in drinking water. Those involved in all levels of providing public drinking water will find details concerning exposure to radionuclides, the resulting estimated health effects, treatment options, and discussions of the economics and policy consequences of compliance. (See W91-03367 thru W91-03382) (Agostine-PTT)
W91-03366

SCIENTIFIC BACKGROUND FOR THE DEVELOPMENT OF REGULATIONS FOR RADIONUCLIDES IN DRINKING WATER.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
For primary bibliographic entry see Field 5G.
W91-03367

ANALYSIS OF THE HEALTH RISK FROM INGESTED RADON.
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 5C.
W91-03368

RISK ASSESSMENT AND CONTROL MANAGEMENT OF RADON IN DRINKING WATER.
Oak Ridge Associated Universities, Inc., Washington, DC.
W. A. Mills.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 27-37. 4 tab, 12 ref.

Descriptors: *Drinking water, *Legal aspects, *Radioisotopes, *Radon, *Risk assessment, *Risks, *Water quality management, Cancer, Dose-response relationships, Legislation, Path of pollutants, Political aspects, Probable deaths, Regulations, Safe Drinking Water Act, Water quality standards, Wells.

The role of risk assessment and risk management of radon in drinking water was reviewed. It is noted that risk assessments for the public health consequences of radon in drinking water require information on radon concentration in water, exposure pathways, and dose-response relationships. On the other hand, risk management involves assumptions of risk acceptance and the establishment of governmental policies in accord with society's acceptance of these assumptions. Although risk assessment for radon exposures can be reasonably qualitative, risk management is clearly judgmental. The following conclusions/recommendations were made. (1) The presence of radon in drinking water is estimated to have its greatest health impact on the 18% of the U.S. population served by private wells. (2) Although no direct evidence exists associating radon in water with health problems, the diseases that are associated with radon in drinking water are stomach cancer from ingestion and lung cancer from inhalation of radon decay products released during household use of water. (3) Using a number of questionable assumptions, the total number of cancer deaths per year attributable to radon in water is estimated to be about 5000 as a maximum value, with essentially all cases occurring in the population served by private wells. (4) Promulgating federal regulations to control radon levels in water under the Safe Drinking Water Act seems unwarranted, since private wells would not likely be regulated. (5) Government control programs should be limited to emphasizing an awareness of possible substantially higher than average levels of radon in water in certain geological areas. (See also W91-03366) (Agostine-PTT)
W91-03369

TREATMENT TECHNOLOGY FOR REMOVING RADON FROM DRINKING WATER SUPPLIES.
New Hampshire Univ., Durham. Environmental Research Group.
N. E. Kinner, P. A. Quern, G. S. Schell, C. E. Lessard, and J. A. Clement.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 39-50. 5 fig, 1 tab, 12 ref. U.S. EPA Water Engineering Research Laboratory, New Hampshire Department of Environmental Services, and University of New Hampshire Environmental Research Group Cooperative Agreement CR812602.

Descriptors: *Drinking water, *Radioisotopes, *Radon, *Water treatment, *Water treatment facilities, Aeration, Economic aspects, Field tests, Groundwater, Maximum contaminant levels, Water quality standards.

Radon contamination of drinking water primarily affects individual homeowners and small communities using groundwater supplies. Treatment alternatives must be included as part of the maximum contaminant level (MCL) regulation for radon in drinking water, which is expected to be published by the U.S. EPA in 1991. As a result, hundreds of small communities will need treatment systems operating at greater than 90% removal efficiency. Three types of treatment processes have been used to remove radon from drinking water supplies: granular activated carbon (GAC) adsorption, diffused bubble aeration, and packed tower aeration. The U.S. EPA has sponsored field evaluations of GAC, diffused bubble aeration, and packed tower aeration, as well as several modifications to existing water storage tanks. A synopsis of the results of these field evaluations is presented. It was found that the selection of an appropriate treatment system to remove radon from drinking water depends primarily upon: (1) percent removal, (2) capital and operating and maintenance costs, (3) safety, (4) raw water quality with respect to parameters such as Fe, Mn, bacteria, and organics. The radon removal efficiency of the diffused bubble and packed tower aeration exceeded 99% at A:W ratios of 15:1 and 5:1, respectively; the GAC system averaged 81 plus or minus 7.7%. Capital and operating and maintenance costs for GAC treatment are favorable for point-of-entry and very small community water supplies; aeration systems are favorable for larger community supplies. In small communities where storage tanks exist and a moderate level of radon removal is required, low cost/low technology modifications may be an acceptable treatment alternative. (See also W91-03366) (Agostine-PTT)
W91-03370

RAID ON SANITY: POLICY AND ECONOMIC ANALYSIS OF RADIONUCLIDE REMOVAL FROM DRINKING WATER.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
D. W. Schnare.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 141-157. 1 fig, 7 tab, 3 ref.

Descriptors: *Drinking water, *Economic aspects, *Policy making, *Public relations, *Radon, *Risk assessment, *Water quality standards, *Water treatment, Administrative decisions, Analytical methods, Data interpretation, Marketing, Political aspects, Precision, Public opinion, Public policy, Uncertainty.

An overview of the presentation of summary risk-management data is given. This is the kind of data presented to decision makers when setting drinking-water standards; it is also the basis for public statements, press releases, and news stories. Although risk-management data can be explained, none of it can be confirmed as true. The basic techniques by which the analyst manipulates the data, the decision maker, and, therefore, reality are presented. Advice is given on either exposing the manipulators, thence gaining greater radon sanity, or on improving one's manipulative skills, thus increasing chances of success in one's own 'raid on sanity'. A few rules are given that can be used to distort or focus available data. These rules also underlie analysis of data and the selection of analytical methods. These rules are split into two groups: those dealing with the news media and those dealing directly with data presentation. To get a story onto the evening news or the front page of the newspaper empirically-derived press rules apply. The story should include as many of the following as possible: (1) harm, pain, suffering, or death; (2) big names, (3) big money; (4) sex; and (5) controversy. The second set of rules applies to the frame of reference used in analysis of risk and cost. The common approaches followed are (1) the 'Bounding Box Problem'--the problem of the appropriateness of the boundaries within which risk and cost analysis is done or presented; (2) data comparisons--summary data are generally meaningless unless they are compared with other data familiar to the intended audience; (3) theoretical integrity--there are limits, both practical and logi-

cal, to the use of theoretical constructs since they can be twisted or misused; and (4) accuracy and precision--characterizing uncertainty seems to be a forgotten concept (It is done through precision and accuracy; both are necessary). (See also W91-03366) (Agostine-PTT)
W91-03374

REMOVAL OF URANIUM FROM DRINKING WATER BY CONVENTIONAL TREATMENT METHODS.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
T. J. Sorg.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 173-191. 11 fig, 7 tab, 17 ref.

Descriptors: *Drinking water, *Radioisotopes, *Uranium, *Water quality standards, *Water treatment, Analytical methods, Coagulation, Field tests, Filtration, Groundwater, Ion exchange chromatography, Maximum contaminant levels, Water softening.

The Environmental Protection Agency's (EPA) drinking water regulations currently do not contain a maximum contaminant level (MCL) for uranium. Because uranium has not been regulated, treatment methods have not been extensively investigated nor has full-scale treatment been widely applied to water supplies. With the anticipation that a MCL would likely be established in the future, EPA has sponsored several uranium removal studies during the past 4-5 years. Since uranium can occur in both surface and groundwaters, treatment technologies have been evaluated to handle both types of waters. Conventional treatment technologies have been evaluated on either a laboratory of field-scale level, and a summary of their effectiveness is given. The results indicate that coagulation/filtration, lime softening, anion exchange, and reverse osmosis are capable of removing uranium down to the 1-5 microgram/L range. Although laboratory and pilot plant studies have been conducted to evaluate a variety of treatment methods, few full-scale systems have been built to remove uranium primarily because an uranium regulation has not been formally established. Data from full-scale conventional coagulation/filtration have shown uranium to be effectively removed, but the data are very limited and influent concentrations are generally very low. Several small anion exchange systems have been installed at schools, and these systems are performing very effectively. (See also W91-03366) (Agostine-PTT)
W91-03377

PRICE OF CONFIDENCE: THE RATIONALITY OF RADIUM REMOVAL FROM DRINKING WATER.
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
D. J. Crawford-Brown.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 213-223. 2 fig, 1 tab, 16 ref.

Descriptors: *Drinking water, *Policy making, *Public health, *Radium, *Regulations, *Risk assessment, *Water quality standards, *Water treatment, Confidence limits, Economic aspects, Mathematical studies, Political aspects, Probabilistic process, Probable deaths, Radioisotopes, Rational formula.

An approach to assessing the rationality behind any decision to set a regulatory limit on radium removal is examined. It is assumed that the goal of the Environmental Protection Agency (EPA) is to limit the concentration of radium in water supplies and, therefore limit the average probability of death, P, from the radium to a prescribed limit. The central concept addressed is the regulatory limit which would lower the concentration of radium in a water supply to a level at which the EPA is 90% confident that the actual probability will be P or less. The contention is that any EPA action would fail to be rational (although it may be justified by other means) if some designated confidence was not reached prior to setting a limit. Two competing concepts of rationality are presented. They agree that being rational implies developing a line of reasoning showing why the final action may be expected to bring about the stated goals and they differ only in what is to be meant by the term 'expected'. In the formalist camp of rationality, an action is arrived at rationally if the underlying line of reasoning uses the best available tools. The second camp derives from a tradition of craftsmanship and adequacy of solution. Here it is necessary to show that there is a reasonable belief that an action will bring about the goals. Some idea of sufficiency of evidence must be introduced. Also some measure of confidence must be developed if the action is said to be rational. The approach given for measuring confidence requires that all values of P from zero to unity be examined. In this manner, it is ensured that the sum of all confidences be equal to unity. Little confidence may be placed on any statement asserting that the value of P associated with a regulatory limit X is a single value. Increased confidence is gained when regulatory limits are justified only by statements about intervals. (See also W91-03366) (Agostine-PTT)
W91-03380

REMOVAL OF RADIUM FROM DRINKING WATER.
Houston Univ., TX. Dept. of Civil and Environmental Engineering.
D. A. Clifford.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 225-247. 7 fig, 2 tab, 34 ref.

Descriptors: *Drinking water, *Radioisotopes, *Radium, *Water quality control, *Water treatment, Adsorption, Brackish water, Economic aspects, Filtration, Ion exchange, Radioactive waste disposal, Radioactive wastes, Reverse osmosis, Sludge, Waste disposal, Wastewater, Water quality management, Water softening.

The traditional, proven process for radium removal are sodium ion exchange softening (>95% removal before hardness breakthrough), lime softening (75%-95% removal), and reverse osmosis (>96% removal). The newer, radium-specific column processes include adsorption onto the Dow RSC and BaSO4-impregnated alumina. The most promising new radium-specific treatment process for large-scale use is adsorption onto preformed manganese dioxide followed by multimedia or diatomaceous earth filtration. The disposal of radium-contaminated wastewaters and sludges from processes under consideration will be a major factor in process selection. The processes of choice for municipal water supply treatment to remove radium are sodium ion exchange softening, lime softening, manganese dioxide adsorption-filtration, and selective adsorption onto the Dow RSC or BaSO4-impregnated alumina. Where the water is brackish, reverse osmosis hyperfiltration should also be considered. The radium removal process of choice for whole-house or point-of-entry treatment is sodium ion exchange softening. For point-of-use radium removal, a standard reverse osmosis system including cartridge filtration, activated carbon adsorption, and reverse osmosis hyperfiltration is recommended. Although no cost estimates have been made, the relative costs (excluding waste disposal), from most expensive to least expensive, for radium removal in small community water supplies are reverse osmosis, sodium ion exchange softening, lime soda softening, manganese dioxide adsorption-filtration, and the radium-selective adsorbents. (See also W91-03366) (Agostine-PTT)
W91-03381

DISPOSAL OF RADIUM FROM DRINKING WATER TREATMENT.
Wisconsin Dept. of Natural Resources, Madison. Public Water Supply Section.
For primary bibliographic entry see Field 5E.
W91-03382

INGESTION OF CHLORINATED WATER HAS NO EFFECT UPON INDICATORS OF CARDIOVASCULAR DISEASE IN PIGEONS.
New York Univ. Medical Center, NY. Inst. of Environmental Medicine.
A. Penn, M. Lu, and J. L. Parkes.
Toxicology TXCYAC, Vol. 63, No. 3, p 301-313, September 1990. 1 fig, 3 tab, 34 ref. NIEHS Center Grant 00260; U.S. Environmental Protection Agency Cooperative Agreement CR813465.

Descriptors: *Birds, *Chlorination, *Drinking water, *Human diseases, *Public health, *Toxicology, *Water pollution effects, Animal diseases, Calcium, Diets, Feeds, Lipids, Population exposure, Water quality.

Cardiovascular disease (CVD) accounts for nearly half the deaths, yearly, in the United States. The arterio(athero)sclerotic plaque is the principal lesion of CVD. The White Carneau (WC) pigeon is an animal model that has been employed extensively for studying CVD. Cholesterol (CHOL) feeding aggravates atherosclerosis in WC pigeons >2 years old. In 1986, two reports appeared from a single laboratory claiming a direct effect of drinking chlorinated (Cl) water upon lipid levels and plaque development in young (<1 year) WC pigeons. These are the only reports of such direct effects, to date. Three month's exposure to 2 ppm or 15 ppm Cl in the drinking water resulted in increased circulating CHOL levels in young male WC pigeons fed a normocholesterolemic (NC) diet in which Ca(+2) levels were reduced. In addition, at both Cl concentrations there was a significant increase in plaque size, compared to controls. Pigeons in the 2 ppm group also exhibited elevated low density lipoprotein (LDL) levels after 3 months on the NC diet. These findings, if extrapolated to man, could have considerable public health consequences, since nearly 200 million people in the U.S. drink Cl water. A similar set of studies has been carried out with strikingly different results. The same pigeon suppliers and feed were used as in the 1986 reports, and the same approach was followed. Six-month-old WC pigeons drank water with 2 ppm or 15 ppm Cl (pH 8.5) and ate a NC diet with Ca(+2) reduced to 80% of normal. At both 1 and 3 months, body weight, CHOL, triglyceride, and LDL levels were unaffected by drinking Cl water. There was also no effect of Cl water on plaque size after 3 months. Thus, no evidence was found that drinking chlorinated water has any effect upon circulating lipid levels or upon the development of arteriosclerotic plaques, in this animal model. (Author's abstract)
W91-03502

IMPACT OF INADEQUATE SANITARY CONDITIONS ON HEALTH IN DEVELOPING COUNTRIES.
London School of Hygiene and Tropical Medicine (England). Maternal and Child Epidemiology Unit.
For primary bibliographic entry see Field 5C.
W91-03505

CAN CONTAMINATED AQUIFERS AT SUPERFUND SITES BE REMEDIATED.
Oak Ridge National Lab., TN. Office of Risk Analysis.
C. C. Travis, and C. B. Doty.
Environmental Science and Technology ESTHAG, Vol. 24, No. 10, p 1464-1466, October 1990. 12 ref.

Descriptors: *Aquifer management, *Aquifers, *Groundwater pollution, *Site remediation, *Superfund, Environmental policy, Groundwater, Groundwater management, Groundwater quality, Water policy, Water pollution control.

The prevailing view among environmentalists and Superfund site managers is that aquifers at Superfund sites can be restored through groundwater pumping. In fact, approximately 68% of Superfund Records of Decision select groundwater pumping and treating as the final remedy to achieve aquifer restoration. The fact is, however, that contaminated aquifers cannot be restored through pumping and treating. Leading groundwater scientists have predicted that continuous pumping for as long as 100-200 years may be needed in order to lower concentrations by a factor of 100. In spite of this

observation, aquifer restoration is the remedial objective at approximately 93% of the sites known to involve nonaqueous-phase liquids. Experience shows that pumping and treating for aquifer restoration does not work. Typically, an initial drop in concentrations by a factor of 2-10 is seen, followed by a leveling with no further decline. To meet the challenge of aquifer restoration, policy makers must acknowledge that aquifer restoration is currently technically impossible. A more appropriate groundwater classification system must be developed. Discontinuation of the Applicable or Relevant and Appropriate Requirements as cleanup goals for aquifer restoration, which is unrealistic and misleading, is recommended. Plume containment and contaminant mass reduction should become primary goals and it should be recognized that restoring aquifers to a pristine condition is not always necessary. Efforts should be made to prevent future contamination and to assign a high priority to waste minimization efforts. (Mertz-PTT)
W91-03508

PHOTOCATALYTIC DEGRADATION OF ATRAZINE AND OTHER S-TRIAZINE HERBICIDES.
Parma Univ. (Italy). Ist. di Chimica Fisica Applicata.
W. Pelizzetti, V. Maurino, C. Minero, V. Carlin, and E. Pramauro.
Environmental Science and Technology ESTHAG, Vol. 24, No. 10, p 1559-1565, October 1990. 11 fig, 1 tab, 59 ref. CNR, MPI, Eniricerche, Regione Piemonte, E.S.O. contract DAJA 45-85-C-0023 and EV4V-0068-C(CD).

Descriptors: *Fate of pollutants, *Herbicides, *Photolysis, *Triazine herbicides, *Water treatment, Atrazine, Chromatography, Cyanuric acid, Degradation, Prometon, Prometryn, Simazine, Trietazine, Water purification.

The photocatalytic degradation of s-triazine herbicides (atrazine, simazine, trietazine, prometon, and prometryn) has been investigated by using particulate TiO2 as photocatalyst under simulated solar light. The herbicides are rapidly degraded. Traces of atrazine (at ppb level) are decomposed in very short times to less than 0.1 ppb but full mineralization of the herbicides is not observed. Degradation products have been monitored through liquid, gas, and ion chromatography, and the overall degradation process has been monitored through dissolved and particulate organic carbon measurements. Several intermediates have been identified, and cyanuric acid has been recognized as the final product of the degradation process for all the investigated herbicides. The process has been shown to lead to the formation of 2,4,6-trihydroxy-1,3,5-triazine (cyanuric acid) rather than to the complete mineralization often observed for other classes of substrates. Photocatalytic process have been recently proposed as a viable method for water purification. From the substrates examined the final formation of cyanuric acid, a compound reported to have low toxicity, and the complete mineralization for other classes of substrates are promising. (Mertz-PTT)
W91-03511

TOXICOLOGY AND DRINKING WATER REGULATIONS.
For primary bibliographic entry see Field 5G.
W91-03526

ASSESSING TOXICITY OF DRINKING WATER CONTAMINANTS: AN OVERVIEW.
Vanderbilt Univ., Nashville, TN. Dept. of Biochemistry.
For primary bibliographic entry see Field 5A.
W91-03527

ROLE OF SHORT-TERM TESTS IN EVALUATING HEALTH EFFECTS ASSOCIATED WITH DRINKING WATER.
Environmental Protection Agency, Cincinnati, OH.
For primary bibliographic entry see Field 5C.
W91-03528

CANCER RISK ASSESSMENT: IMPORTANCE OF IDENTIFYING MECHANISMS OF ACTION.
Washington State Univ., Pullman. Coll. of Pharmacy.
For primary bibliographic entry see Field 7B.
W91-03529

COMPARATIVE SUBCHRONIC TOXICITY STUDIES OF THREE DISINFECTANTS.
Health Effects Research Lab., Cincinnati, OH.
F. B. Daniel, L. W. Condie, M. Robinson, J. A. Stober, and R. G. York.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 10, p 61-69, October 1990. 7 tab, 39 ref.

Descriptors: *Chlorination, *Chlorine, *Disinfection, *Public health, *Toxicity, *Toxicology, Chlorine dioxide, Drinking water, Halogens, Health effects, Monochloramine.

The principal goal of disinfecting water supplies is the elimination of pathogens that are responsible for waterborne diseases. Chlorination is a successful method for achieving this goal and has been the predominant method of drinking water disinfection in the United States for more than 70 years. There has been concern in recent years about the health effects of trihalomethanes and other by-products formed during chlorination when chlorine reacts with organic material contained in surface water. In separate subchronic toxicity studies, male and female sprague-Dawley rats received various dosages of chlorine, monochloramine, or chlorine dioxide in their drinking water for 90 consecutive days. None of the disinfectants caused premature death at any of the concentrations used. The highest dose of chlorine tested (250 mg/L) was concluded to be a no observable adverse effect level. At 200 mg/L (the lowest observable adverse effect level), monochloramine produced decreased body and organ weights in both sexes and a small decrease in red blood cell count and serum calcium in males. Chlorine dioxide produced dosage-related decreases in body organ weight at concentrations as low as 25 mg/L, but it most significant toxic effects was the induction, at all concentrations, of nasal lesions. These studies establish that the subchronic toxicity of the three disinfectants in rats is chlorine dioxide >> monochloramine > chlorine, when administered in drinking water. (Mertz-PTT)
W91-03530

REMOVING AQUATIC ORGANIC SUBSTANCES BY ANION EXCHANGE RESINS.
CH2M Hill, Santa Ana, CA.
P. L. K. Fu, and J. M. Symons.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 10, p 70-77, October 1990. 12 fig, 7 tab, 13 ref. US EPA, Office of Research and Development grant R-812155-01-0.

Descriptors: *Anion exchange, *Dehalogenation, *Drinking water, *Water treatment, Adsorption, Ion exchange, Organic matter, Resins.

The removal of organic substances from drinking water supplies has become a major concern since trihalomethanes were found in chlorinated drinking water in 1974. The US EPA recommended that water utilities should lower the organic content of their water as much as possible prior to the use of any oxidant as a disinfectant. The anion exchange process is an attractive method for removing aquatic organic substances because the majority of them are acidic (ionic). The mechanisms of removal of aquatic organic substances by anion exchange resins, influence of resin properties and clarification processes on removal, and chromatographic behavior of organic substances in anion exchange columns were verified. Depending on the type of resin and the nature of the organic matter, anion exchange resins removed up to 80% of the dissolved organic matter in natural waters. Except for some nonionic organic matter that passes directly through the ion exchange column, the resin removed organic material in preference to some common anions in natural water. Ion exchange was the dominant resin removal mechanism for all organic fractions. Surface adsorption, however, also contributed to the removal of some organic matter. Resin skeleton and pore structure were interrelated; their impact on the removal of each organic fraction depended on the characteristics of the fraction. Overall, however, resin skeleton, which affects degree of swelling of the resins, was more important than pore structure. Highly swelled resins with acrylic skeletons removed more aquatic organic substances than resins with rigid polystyrenic skeletons. (Mertz-PTT)
W91-03531

ASSESSING OZONATION RESEARCH NEEDS IN WATER TREATMENT.
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
P. C. Singer.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 10, p 78-88, October 1990. 120 ref.

Descriptors: *Drinking water, *Ozonation, *Water treatment, Amines, Aromatic compounds, Biocides, Coagulation, Disinfectants, Iron, Manganese, Olefins, Sulfides.

Ozone has been used for drinking water treatment on a municipal scale since 1906. Today, more than 1000 drinking water treatment facilities in Europe employ ozonation as part of their overall treatment train. Interest in ozonation in the United States has increased. Ozone can react with organic contaminants in natural water via two principal pathways. It can react directly, as molecular ozone, through reactions that are highly selective. In general, under the conditions employed in drinking water treatment, activated aromatic compounds, olefins and simple amines would be expected to react quickly with molecular ozone. Alternatively, ozone can react with contaminants via an indirect pathway whereby the free radical species arising from ozone decomposition serve as the oxidizing species. Ozone is an effective oxidant for reduced inorganic species, such as ferrous iron, manganous manganese, and sulfide. It is also a very effective biocide. Its principal limitation as a disinfectant is its instability in water. For this reason, ozone cannot be used as a final disinfectant in the distribution system. There are numerous mechanisms by which ozone can facilitate coagulation. Many raw water quality characteristics and treatment parameters may intervene in the ozonation-coagulation process. The practical oxidation of organic impurities in water by ozone produces material that tends to be more biodegradable than the parent species. Using ozone as a final disinfectant can lead to extensive biological regrowth in the distribution system, an obvious disadvantage of terminal ozonation. However, if ozone is applied to the water prior to its contact with a bed or porous media, biodegradation can take place within the bed, producing a water that is biologically stable. The most serious issue related to the widespread use of ozone for drinking water treatment is the question of by-product formation and health effects. Major research is needed to develop analytical methods to identify by-products of ozonation and to conduct health effects bioassays. (Mertz-PTT)
W91-03532

FATE OF CHLOROTHALONIL IN GROUND WATER IN COMMERCIAL CRANBERRY CULTURE IN THE NEW JERSEY PINE BARRENS.
Cook Coll., New Brunswick, NJ. Dept. of Environmental Science.
For primary bibliographic entry see Field 5B.
W91-03533

USE OF FLYASH AS AN ION EXCHANGER IN WATER FILTRATION STUDIES FOR THE REMOVAL OF HEAVY METALS.
Industrial Toxicology Research Centre, Lucknow (India).
R. K. Sharma, S. Kumar, A. K. De, and P. K. Ray.
Journal of Environmental Science and Health (A)

JESEDU, Vol. 25, No. 6, p 637-651, August 1990. 6 fig, 4 tab, 25 ref.

Descriptors: *Adsorbents, *Drinking water, *Fly ash, *Heavy metals, *Ion exchange, *Water treatment, Adsorption, Chromium, Iron, Lead, Manganese, Sand filters.

Fly ash as an adsorbent was found to be effective for the removal of heavy metals after generation with 2.3% HCl at about pH 6. Iron, lead, manganese and chromium ions were studied for their adsorption efficiency. In the experiments in which metals were tested separately, lead showed a maximum of 93% adsorption. In a mixture iron showed maximum adsorption and for lead adsorption was reduced to 28%. Chromium showed the minimum adsorption of 6.3% when tested individually and 13.03% in a mixture. On the basis of these data, testing of fly ash at the pilot plant level versus the slow sand filtration method for the purification of drinking water is recommended. (Author's abstract)
W91-03535

REMOVAL OF IRON FROM WATER BY COAL FLY ASH.
Industrial Toxicology Research Centre, Lucknow (India).
A. K. De, and M. M. Lal.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 6, p 665-677, August 1990. 3 fig, 4 tab, 10 ref.

Descriptors: *Adsorbents, *Drinking water, *Fly ash, *Iron, *Water treatment, Adsorption, Chromium, Copper, Hydrogen ion concentration, Lead, Manganese, Metals, Natural waters.

The use of coal fly ash, an industrial solid waste, for removal of iron from water was investigated. At concentrations of iron below 3.5 mg/L, 100% of iron was removed with a 6 cm bed depth at pH 3.5. Increasing iron concentrations resulted in decreasing adsorption efficiency of coal fly ash. The optimal pH for iron removal was 4.1, and the adsorption was found to conform to Freundlich's adsorption isotherm. The process was applied to natural water from five sites. More than 80% of the iron was removed in all cases. The treatment also removed Mn, Cu, Cr, and Pb but resulted in increased levels of Mg and Ca. The removal of anions, chemical oxygen demand, and dissolved solids was not significant. It is concluded that coal fly ash is effective for decreasing the concentrations of toxic metals to levels permissible for drinking water. The method is recommended as an economical means of iron removal from polluted water. (MacKeen-PTT)
W91-03537

WASTEWATER AND WATER TREATMENT: ANION EXCHANGE (JAN 77-MAY 89). CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE.
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 10C.
W91-03570

METHODS FOR THE DETERMINATION OF ORGANIC COMPOUNDS IN DRINKING WATER.
Environmental Monitoring Systems Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5A.
W91-03580

NUTRIENTS FOR BACTERIAL GROWTH IN DRINKING WATER: BIOASSAY EVALUATION.
Academy of Natural Sciences of Philadelphia, Avondale, PA. Stroud Water Research Center.
L. A. Kaplan, and T. L. Bott.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-213995. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/600/2-89/030, July 1989. 51p, 2 fig, 18 tab, 44 ref. EPA Contract No. CR813135-01-0.

Descriptors: *Bacterial growth, *Bioassay, *Drinking water, *Nutrients, *Pollutant identification, Bacteria, Dissolved organic carbon, Distribution systems, Microbiological studies, Organic carbon, Water quality.

The regrowth of bacteria in drinking water distribution systems can lead to the deterioration of water quality. Pathogenic bacteria are heterotrophs, and heterotrophs are probably the dominant bacteria associated with the regrowth phenomenon. Only a portion of the total organic carbon in drinking water is biologically labile to heterotrophic bacteria, and a bioassay developed to quantify this assimilable organic carbon (AOC) has been proposed as an index of the regrowth potential of drinking water. Both biological and chemical assays have been evaluated for determining AOC as related to regrowth of bacteria in drinking water from surface water and groundwater sources. Pseudomonas fluorescens strain P-17 was used in bioassays for AOC. Dissolved organic carbon (DOC), UV-labile DOC, DOC < 10,000 daltons, monosaccharides, and primary amines were the chemical assays used to predict concentrations of AOC. Growth of P-17 was enumerated as viable and total cells with spread plates and direct epifluorescence microscopy. AOC concentrations in surface waters ranged from 48 to 607 microgm/L and in groundwater supply from 40 to 146 microgm/L. AOC remained relatively constant or declined in distribution systems with distance from the treatment plant. Incubation vessel surface to volume ratio influenced the AOC value by enhancing wall growth of reversibly attached cells. The bioassay assumes that: (1) organic carbon limits growth of the bioassay organism; (2) the yield of the bioassay organism on naturally occurring AOC is constant and equal to yield on model organic compounds; and (3) the bioassay organism is an appropriate surrogate for the native microflora of distribution systems in utilizing AOC. It was found that phosphorus additions to some test waters were required to generate carbon limitation and that yield of P-17 on naturally occurring AOC approximates the yield on acetate. Correlations of the bioassay AOC with chemical determinations were poor, but with improvements that were made in the handling of the test water, glassware, and P-17, it was suggested that the bioassay holds promise for a simple, routine measure of drinking water regrowth potential. (Author's abstract)
W91-03590

COMPARISON OF FALLING-FILM AND GLASS-TUBE SOLAR PHOTOCATALYTIC REACTORS FOR DESTROYING TOXIC ORGANIC CHEMICALS IN WATER.
Sandia National Labs., Albuquerque, NM. Solar Thermal Collector Technology Div.
J. E. Pacheco, and J. T. Holmes.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-010688. Price codes: A03 in paper copy, A01 in microfiche. Report No. SAND--88-2726C, (1989). 13p, 8 fig, 16 ref. DOE Contract DE-AC04-76DP00789.

Descriptors: *Laboratory methods, *Organic compounds, *Photochemistry, *Photolysis, *Wastewater treatment, *Water treatment, Chemical reactions, Comparison studies, Ultraviolet radiation.

Photocatalytic destruction of a model compound has been demonstrated with bench scale and with two engineering scale experiments. For the engineering scale experiments, two solar concentrating hardware systems were used: glass-tube rough system and a falling-film/heliostat. The ultraviolet (UV) power on the reactors of the bench scale, glass-tube/trough and falling film/heliostat systems were 0.15, 1600 and 5200 watts of UV. In the bench scale experiments, the use of hydrogen peroxide as an oxidant with a titanium dioxide catalyst under ultraviolet illumination yielded reaction rates an order of magnitude greater than without the oxidant. The thermal performances of both solar systems are favorable for photocatalytic processes, since mineralization of the contaminant can take place before boiling occurs. The trough/glass tube system was evaluated in clear and partly cloudy weather, and the amount of time to attain the same level of destruction was proportional to the total incident solar energy. With the heliostat falling-film system, experiments were performed at two power levels. The concentration of the model compound was reduced below detectable limits in less than 30 seconds of exposure. Preliminary data indicate initial reaction rates are linear with ultraviolet intensity, though further experimental studies will need to be performed to verify this relation. (Author's abstract)
W91-03595

EFFECTS OF CHLORINE DIOXIDE ON THE DEVELOPING RAT BRAIN.
Health Effects Research Lab., Research Triangle Park, NC. Developmental Toxicology Div.
G. P. Toth, R. E. Long, T. S. Mills, and M. K. Smith.
Journal of Toxicology and Environmental Health JTEHD6, Vol. 31, No. 1, p 29-44, September 1990. 24 ref.

Descriptors: *Chlorine dioxide, *Disinfection, *Toxicology, *Water pollution effects, *Water treatment, Animal physiology, Biochemistry, Laboratory animals.

Chlorine dioxide (ClO_2) is being considered as a drinking water disinfectant since it does not result in the formation of trihalomethanes and does not react with phenol to produce the unpleasant taste of water associated with chlorine treatment. Due to its possible impact on public health, the potential toxicity of ClO_2 and its reduction products, chlorite and chlorate, has been investigated. A study was conducted to characterize the developmental neurotoxic potential of direct ClO_2 exposure and to explore the involvement of the thyroid hormone system in any developmental abnormality. Male and female Long-Evans rat pups, exposed to an oral dose of 14 mg ClO_2/kg/d (postnatal d 1-20), were examined for effects on brain development and for changes in thyroid activity. Body weight reductions were observed on postnatal (pn) d 11, 21, and 35. Forebrain weight and protein content were decreased on pn d 21 and 35, as were the DNA content on d 35 and the number of dendritic spines on cerebral cortical pyramidal cells, a marker for synapse formation. Otherwise, cell proliferation in the forebrain, cerebellum and olfactory bulbs was normal, as were migration and aggregation of neuronal cells in three areas of the cerebral cortex. Histopathology of the forebrain, cerebellum and brainstem showed no gross lesions. (Author's abstract)
W91-03880

ENVIRONMENTAL ASPECTS OF CRYPTOSPORIDIUM SPECIES: A REVIEW.
Scottish Parasite Diagnostic Lab., Glasgow. Dept. of Bacteriology.
H. V. Smith.
Journal of the Royal Society of Medicine JRSMD9, Vol. 83, No. 10, p 629-631, October 1990. 1 tab, 16 ref.

Descriptors: *Drinking water, *Human diseases, *Infection, *Literature review, *Path of pollutants, *Potable water, *Protozoa, *Water pollution effects, Public health, Species composition, Water quality.

In the last decade, Cryptosporidium has been recognized as one of the most common causes of acute self-limiting gastroenteritis caused by a protozoan parasite in immunocompetent people. Infection in the immunocompetent has been described in 26 countries, with a reported prevalence of 0.6-20% in western countries and 4-20% in developing countries. In the last 10 years, the importance of waterborne transmission of cryptosporidiosis has been accepted worldwide. Five outbreaks of waterborne cryptosporidiosis have been documented, and in one an estimated 13,000 persons were affected, indicating the large numbers of consumers at risk of contracting disease from contaminated potable water. In two of the outbreaks, post-treatment

contamination was assumed to be the cause, but two outbreaks have occurred when water treatment works produced final water which met the accepted standards of water quality for that country. Oocysts can gain access into potable water systems by a variety of routes; up to 16,000 mg/L of free chlorine is necessary to reduce the in vitro excystation of human-derived oocysts to zero. Oocysts have been detected in wastewater (range 3.3-20,000/L), surface water receiving agricultural or wastewater discharges (range 0.006-2.5/L), pristine surface water (0.02-0.08/L), drinking water (0.006-4.8/L) and recreational water (0.66-500/L). Detecting oocysts in potable water does not necessarily mean that the consumer is at risk as neither the species nor the viability of such oocysts is known. In order to assess the impact of waterborne oocysts on human cryptosporidiosis, further nationwide studies on their occurrence in raw waters for abstraction and potable waters are being undertaken. In the absence of methods for differentiating between living and dead sporozoites contained within the oocyst, currently each oocyst detected in water is regarded as being viable, and hence potentially infective to man. Therefore, an assay for differentiating a viable from a non-viable oocyst will be of great advantage to the water industry, when assessing the risk of contracting waterborne cryptosporidiosis. (Lantz-PTT)
W91-03881

DETERMINATION OF RADON IN WATER BY ARGON PURGING AND ALPHA COUNTING WITH A PROPORTIONAL COUNTER.
Ecole Polytechnique, Montreal (Quebec).
For primary bibliographic entry see Field 7B.
W91-03888

5G. Water Quality Control

HYDROGEOLOGY AND WATER RESOURCES OF THE LOS OSOS VALLEY GROUNDWATER BASIN, SAN LUIS OBISPO COUNTY.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-02971

INFORMATION EXCHANGE ON MODELS AND DATA NEEDS RELATING TO THE IMPACT OF AGRICULTURAL PRACTICES ON WATER QUALITY: WORKSHOP PROCEEDINGS.
Proceedings of the Workshop held February 5-8, 1990, Reston, Virginia. U.S. Geological Survey, Reston, Virginia. 1990. 217p. Cosponsored by: U.S. Geological Survey, Agricultural Research Service, and Soil Conservation Service.

Descriptors: *Agriculture, *Information exchange, *Model studies, *Nonpoint pollution sources, *Water pollution control, *Water resources management, *Workshops, Agricultural chemicals, Databases, Environmental quality, Farming, Geographic information systems, Governmental interrelations, Interagency cooperation, Research priorities, Water quality.

This report documents workshop proceedings, opening with a discussion of the background and objectives of the workshop and recommendations from the steering committee on future continuance of the information exchange. Part I of the report contains summaries of all the presentations made at the workshop, and is divided into several sections. The first includes introductory remarks, an overview of the Water Quality Initiative in the U.S. Department of Agriculture, the Office of Management and Budget's perspective on the Initiative, and perspectives on the impact of agricultural practices on water quality from representatives of the environmental community, the agribusiness sector, a regulatory agency, and the States. The second section includes reports on current interagency research and technical assistance activities. The third section contains a series of presentations on relevant models and the fourth contains a series of presentations on databases, all made for the purpose of promoting their mutual accessibility and appropriate use. Part II includes the results of a pre-workshop solicitation of information on the content and availability of models and databases pertinent to water quality. The workshop was cosponsored by the U.S. Geological Survey, the Agricultural Research Service, and the Soil Conservation Service, and focused on current interagency efforts to conduct research and design technical assistance programs related to the prevention or mitigation of water quality problems in agricultural areas. (See W91-02986 thru W91-03008) (Fish-PTT)
W91-02985

WATER QUALITY INITIATIVE OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.
C. R. Amerman.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 5-8.

Descriptors: *Agricultural chemicals, *Agriculture, *Government supports, *Governmental interrelations, *Nonpoint pollution sources, *Water pollution control, *Water quality control, Databases, Education, Fertilizers, Groundwater pollution, Nitrates, Nitrites, Pesticides, Research priorities.

American agriculture has achieved unprecedented levels of efficiency, due in part to the use of fertilizers and various pesticides. Some of these applied materials have been found to move from their application sites to become contaminants of off-site soils, water, and air. At or above certain concentrations in water, nitrate and nitrite resulting from the use of nitrogen fertilizer and several pesticides and their breakdown products are known or suspected to be harmful to human health. In recognition of the special problems and priorities associated with minimizing contamination of groundwater, the Congress in 1988 directed federal-wide development of an implementation strategy to significantly reduce the risk of agricultural chemical contamination. In response to the Congress' instructions and with an urgency appropriate to declaration of a presidential initiative, the U.S. Department of Agriculture (USDA) developed an implementation strategy in consultation with the Environmental Protection Agency and the National Oceanic and Atmospheric Administration and in close coordination with the U.S. Geological Survey. The central goal of the strategy is prevention of groundwater contamination by agricultural chemicals, and is comprised of three major national thrusts: (1) to deliver the best available knowledge to the farmer and the rancher through education and technical assistance; (2) to conduct an aggressive, high-priority research and development program for developing new crop production technology; and (3) to develop and maintain an agricultural chemical use database for assessing chemical-use trends and determining problems and geographical areas in need of increased program attention and for evaluation of the overall success of the program. Although the immediate emphasis is on groundwater, the program will assure that surface water quality will also be enhanced. (See also W91-02985) (Fish-PTT)
W91-02986

INTER-AGENCY RESEARCH AND TECHNICAL INTEGRATION.
M. R. Burkart.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 11-12.

Descriptors: *Agriculture, *Governmental interrelations, *Interagency cooperation, *Nonpoint pollution sources, *Research priorities, *Water pollution control, *Water pollution sources, *Water quality control, Fate of pollutants, Groundwater pollution, Management planning, Path of pollutants.

During the last few years the U.S. Geological Survey (USGS) has been examining the impact of non-point sources of water contamination, particularly agricultural chemicals. The mid-continental United States was selected as a region where research questions and methods can be examined at several scales. Results will be transferred to other parts of the nation once methods are developed and some fundamental questions regarding fate and transport of agrichemicals are answered. In February 1989 representatives of the USGS, U.S. Department of Agriculture (USDA), Environmental Protection Agency (EPA), and State agricultural and natural resource agencies and institutions met in Iowa City to discuss the integration and coordination of activities to meet both agronomic and hydrologic needs. The products of the meeting included: (1) establishment of a 'technical integration group' (TIG) as a forum to discuss technical needs and plans and coordinate programs and management plans; (2) consensus for a priority of research categories; and (3) nomination of scientists to form research strategy teams to identify specific research priorities. (See also W91-02985) (Fish-PTT)
W91-02987

PROCESS RESEARCH STRATEGY TEAMS.
Geological Survey, Denver, CO. Water Resources Div.
R. W. Healy.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 13-14.

Descriptors: *Agricultural chemicals, *Agriculture, *Herbicides, *Nonpoint pollution sources, *Research priorities, *Water pollution control, Aeration zone, Biodegradation, Environmental effects, Flow models, Path of pollutants, Solute transport, Sorption.

Three process-research strategy teams were formed as part of the Mid-Continent and Midwest Herbicide Initiatives. The goal of each team was to summarize the current state of knowledge in its respective topic area and to identify areas for further research. The teams were comprised of scientists from federal and state agencies, universities, and private industry. The Subsurface Transport Strategy Team identified preferential flowpaths within the unsaturated zone as the most important aspect of subsurface transport. Specific recommendations of this team were to improve methods for identifying and characterizing preferential flowpaths and to improve models of preferential flow and transport. Future research should extend what is known at the small scale up to field and regional scales. The Sorption/Storage Strategy Team identified four subareas into which previous and recommended research could be grouped: environmental assessment, characterization of chemicals, description of sorption and desorption processes, and geologic and environmental characterization of media. The team stressed the importance of studying metabolites, not only in terms of chemical and physical properties, but also in terms of the sorption and desorption processes. The Biodegradation and Transformation Strategy Team noted that little previous work has been performed in this area. Of primary importance was the identification of the mobile and persistent degradation products of agricultural chemicals and the rates of formation of these products. Other important areas which require further research include the effects of transformation, agricultural practices, crops, climate, and other external factors on sorption. (See also W91-02985) (Fish-PTT)
W91-02988

FATE AND TRANSPORT OF AIRBORNE PESTICIDES: AN OVERVIEW OF ATMOSPHERIC MODELLING REQUIREMENTS.
Agricultural Research Service, Beltsville, MD. Environmental Chemistry Lab.
M. S. Majewski.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Prac-

tices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 33-35, 5 ref.

Descriptors: *Agriculture, *Fate of pollutants, *Model studies, *Nonpoint pollution sources, *Path of pollutants, *Pesticides, *Water pollution control, Agricultural chemicals, Air pollution, Analytical techniques, Computer models, Environmental quality, Numerical analysis, Water pollution sources.

The atmosphere has long been recognized as an important repository for pollutants. Predicting a chemical's behavior in the environment through the use of mathematical models offers a more rapid, less expensive alternative to field measurements. However, an understanding of the environmental, as well as chemical, processes is needed for an educated interpretation of these results. Pesticides enter the atmosphere mainly through the agricultural application process. Post-application volatilization from the field also represents a significant input to the lower atmosphere, but over a much longer time period. Transport and distribution of airborne pesticides is dependent upon the planetary boundary layer, which forms over the surface of the earth, into which it is released. There are two basic types of models that can be used to estimate the environmental fate of pesticides: (1) analytical (those that simulate behavior for typical generic situations and generally require less computer time, less data input, and involve mathematical simplifications), and (2) numerical (those that require more site-specific inputs, and can be run on desktop personal computers). One program which integrates a variety of models which assess a pollutant's fate in air, surface water, groundwater, and soil is the Graphical Exposure Modelling System (GEMS) developed by the Environmental Protection Agency. Using these models to predict airborne movement and deposition of organic compounds is only one step in fully understanding the total environmental behavior of these compounds. They will continue to be modified and improved as understanding of the complex environment increases. (See also W91-02985) (Fish-PTT)
W91-02992

SURFACE WATER QUALITY MODELS.
F. O. Thuerer.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 37-38.

Descriptors: *Computer models, *Hydrologic models, *Model studies, *Nonpoint pollution sources, *Surface water data, *Water pollution control, *Water quality management, Computer programs, Data processing, Databases.

Serious computer modeling in the water resources area began in this decade with hydrologic watershed computer models. The single biggest obstacle interfering with interdisciplinary and inter-institutional water quality model and database development is a standard, systematic management approach to modeling. However, information needs to be gathered to collectively formalize model and database development, such as: (1) determination of the difference between verification and validation and an acceptable level of each; (2) whether there is a need for standard validation methods; (3) types of documentation; (4) determination of the difference between models, numerical approximations, and computer programs; (5) whether using structured systems analysis and design with its resulting 'corporate data dictionary' would 'help coordinate model and database efforts'; (6) whether using the business communities software management methods would help interagency model and database development projects; and (7) if there is an advantage to separating computer models into assessment, evaluating and design/construction/maintenance categories. (See also W91-02985) (Fish-PTT)
W91-02993

POLICY ANALYSIS, AGRICULTURE, AND WATER QUALITY.
J. Miranowski.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 45.

Descriptors: *Agriculture, *Economic evaluation, *Farm management, *Nonpoint pollution sources, *Water pollution control, *Water quality control, *Water resources management, Biological studies, Economic aspects, Environmental quality, Farm income, Farms, Model studies.

There has long existed a gap between aggregate policy analysis (particularly socioeconomic analysis) and location-specific physical and biological science research. The former of necessity stresses broad, aggregate issues, such as price and income effects of changes in agricultural policies, regional shifts in production and income, and the consequences of environmental and resource policies. On the other hand, most physical and biological studies are relevant only at a much narrower, micro level. Economists operate on some fairly basic assumptions: farmers are driven by economic information, as revealed by the relative prices of inputs (agricultural chemicals, labor, capital) and outputs. There are four key relationships that need to be understood in order to integrate scientific knowledge on environmental problems of agricultural production with socioeconomic analysis: (1) input/output substitution: how production changes as the level and intensity of input use changes; (2) input/input substitution: the ability of farmers to substitute one input for another in response to changing market conditions or in response to regulatory decisions; (3) output/output substitution: how farmer's choices of which crops to produce are affected by relative prices and the influence of agricultural commodity programs; and (4) input/environmental quality substitution: how changes in input use affect environmental quality. The eventual goal is to build a general response model, which shows how the agricultural sector responds to environmental programs and policies, seeking to understand how water quality is affected by farm policies, and the changes in production they induce from farmers. (See also W91-02985) (Fish-PTT)
W91-02995

ROLE OF ENVIRONMENTAL MODELING IN THE DECISION-MAKING PROCESS.
G. R. Oliver.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 47-50.

Descriptors: *Agricultural chemicals, *Agriculture, *Decision making, *Environmental impact, *Model studies, *Nonpoint pollution sources, *Water pollution control, Conservation, Probability distribution, Risk assessment, Water quality management, Water resources management.

Many regulators, managers, and scientists now utilize environmental models on a regular basis to help make decisions concerning the environmental safety of agricultural chemicals. Their success in employing these models, however, is often limited or sporadic. Accurate and realistic background information is needed to make decisions on the acceptability of a specific use of a particular agricultural chemical. The models currently used can be divided into two broad categories: screening (typically very simplistic, and relying on few inputs) and assessment (requiring more input data, but providing a more situation-specific answer). When performing a modeling assessment or the associated field studies, the amount of effort required to conduct a full assessment is often minimized and instead focuses on only worst-case conditions. The real key to making modeling assessments a truly effective part of the decision-making process will be the incorporation of the probability component. Decision-makers must begin to go beyond initial answers and use models to explore the possibilities for reducing any unacceptable losses through management and conservation practices. Modeling assessments are typically biased towards reporting environmental risk only, and fail to provide the decision-maker with all the information needed. Model developers need to include scientists from other fields such as crop production, entomology, and economics to broaden these models so the decision-makers can view the entire picture. (See also W91-02985) (Fish-PTT)
W91-02996

EPA'S CEEPES PROJECT: DESCRIPTION AND DATA NEEDS.
A. Manale.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 53-55.

Descriptors: *Agricultural chemicals, *Agriculture, *Economic evaluation, *Environmental impact, *Model studies, *Nonpoint pollution sources, *Pesticides, *Water pollution control, Alternative planning, Corn belt, Path of pollutants.

The Office of Policy, Planning, and Evaluation of the Environmental Protection Agency is conducting a research effort to link quantitative economic models with biogeophysical process models. The modeling system, called the Comprehensive Environmental Economic Evaluations System (CEEPES) is designed to predict the multimedia impacts of pesticide (and eventually also nitrogen fertilizer) use and the associated economic benefits. It is to be used to provide broad assessments of policy options relating to agricultural uses of chemicals at a local, regional, and national scale. The configuration of the model system allows damages to occur through multiple media, with the possibility of interregional and intraregional transport from one medium to another. Because according to the medium through which the damage occurs, the system allows for temporal and spatial aggregation. This in turn is linked to the economic benefits derived from agricultural practices in response to alternative policies. The scope of the modeling analysis is the Midwestern Corn Belt. (See also W91-02985) (Fish-PTT)
W91-02997

SOCIO-ECONOMIC DATA RELATING TO THE WATER QUALITY INITIATIVE.
Economic Research Service, Washington, DC. Resources and Technology Div.
S. R. Crutchfield.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 63-65.

Descriptors: *Agriculture, *Data collections, *Databases, *Economic evaluation, *Nonpoint pollution sources, *Water pollution control, *Water quality management, Data storage and retrieval, Farm management, Model studies.

The U.S. Department of Agriculture has access to several types of socioeconomic data that can be used to study the Water Quality Initiative. General data types are primary source data (derived from surveys), secondary source data (derived from external sources), and analytic models which yield useful data for water quality research (primary or secondary source data filtered through Economic Research Service (ERS) modeling or analytic capabilities). Specific types of data available include: financial data, such as prices received as well as farm costs and returns; cropping practices and land use; input use, including pesticides, fertilizers, machinery, and labor; sociological and demographic data; and international and trade data. These data are made available through the internal ERS database (ARIES); publicly available datasets for distribution via electronic media; periodic ERS reports which include statistical or data tables; and ERS reports. The data or surveys specifically relating to water quality that ERS maintains include: Farm Costs and Returns Survey, Objective Yield

Survey, Water Quality Survey, and an agrichemical leaching loss algorithm and associated database. Approximately $1.0 million has been made for the database component of the Water Quality Initiative and currently a pilot cotton survey is underway. Data or analytic capabilities needed by economists include: linkages to geophysical and hydrogeologic databases; filling in the 'Black Box' (fate, transport, and impact of agricultural chemicals); and better understanding of alternatives to traditional agriculture. (See also W91-02985) (Fish-PTT)
W91-02999

DEVELOPMENT OF THE NATIONAL RESOURCES INVENTORY.
Soil Conservation Service, Washington, DC.
For primary bibliographic entry see Field 7C.
W91-03000

SOLID-EARTH SCIENCE DATA BASES.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 7C.
W91-03001

PESTICIDES IN STREAMS OF THE UPPER MIDWESTERN UNITED STATES.
Geological Survey, Denver, CO.
D. A. Goolsby, and E. M. Thurman.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 89-90, 1 tab, 1 ref.

Descriptors: *Agricultural chemicals, *Herbicides, *Nonpoint pollution sources, *Path of pollutants, *Pollutant identification, *Stream pollution, *Triazine herbicides, *Water pollution control, Distribution, Fate of pollutants, Immunoassay, Midwestern United States.

In 1989, a reconnaissance study was conducted to determine the distribution and concentrations of herbicides in streams in the corn-producing region of the upper midwestern United States. Two specific objectives of this study were to determine the geographic and seasonal distribution of herbicides in streams and to determine the usefulness and limitations of a low-cost, enzyme-based immunoassay analysis for determining triazine-herbicide concentrations on a regional scale. The approach consisted of allocating 150 sampling sites among the 10 states in the study area based on the quantity of corn produced. Each site was sampled three times: (1) prior to application of herbicides (March-April), during the first storm runoff following application of herbicides (May-June), and (3) during the fall (October-November). Several herbicides (atrazine, 90%; desethylatrazine, 51%; metolachlor, 34%; and simazine, 13%) were detected in small concentrations in samples collected prior to application. For samples collected during periods of runoff immediately following application, at least one herbicide was detected in almost every sample (most frequently and in order of occurrence: atrazine-98%, alachlor-86%, desethylatrazine, 86%; metolachlor, 83%; cyanazine, 63%; and simazine, 60%). Immunoassay results from the preapplication and postapplication periods show a good correlation with atrazine results obtained by GC/MS. Results from the third round of sampling are not available at this time. (See also W91-02985) (Fish-PTT)
W91-03002

STATUS UPDATE--NATIONAL PESTICIDE SURVEY.
J. J. Boland.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 95-97.

Descriptors: *Agricultural chemicals, *Drinking water, *Groundwater pollution, *Nonpoint pollution sources, *Pesticides, *Surveys, *Water pollution control, Analytical techniques, Communication, Public health, Risk assessment.

The National Pesticide Survey (NPS) is a jointly sponsored project of the Environmental Protection Agency's Office of Drinking Water and the Office of Pesticide Programs. After completing a successful pilot study in preparation for the implementation of full survey, sampling began in April 1988. Sampling is scheduled to conclude in February 1990. It is convenient and useful to discuss the NPS by its component parts: design, analytical methods, health advisories, and communications. The design component can be viewed as being composed of two separate surveys in one: community water system wells and domestic well systems were sampled. Five new multi-residue analytic methods and a new analytic method for ethylene thiourea were used. Health advisories contain information on health risks and treatment technologies, and specify levels of chemical concentrations in water that are acceptable for drinking. Effective communications has played a major role in the success of the NPS. As the NPS involved numerous individuals and organizations in the implementation process, so too are many of the same involved in the final report process, scheduled for the first quarter of calendar year 1991. (See also W91-02985) (Fish-PTT)
W91-03004

STATE DATA BASE CAPABILITIES, WISCONSIN.
Wisconsin Univ.-Madison. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 7C.
W91-03006

STATE OF MINNESOTA DATA BASE CAPABILITIES.
Minnesota Dept. of Agriculture, St. Paul.
For primary bibliographic entry see Field 7C.
W91-03007

STATE DATABASE CAPABILITIES: THE MICHIGAN EXPERIENCE.
Michigan State Univ., East Lansing. Dept. of Resource Development.
For primary bibliographic entry see Field 7C.
W91-03008

WETLANDS AND WASTEWATER MANAGEMENT: QUESTIONS, ANSWERS, ADVICE, AND GUIDANCE.
Environmental Protection Agency, Chicago, IL. Region V.
K. Wernstedt.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-190409. Price codes: A09 in paper copy, A01 in microfiche. February 1988. 173p, 91 ref, 2 append.

Descriptors: *Decision making, *Project planning, *Wastewater management, *Wastewater treatment, *Wetland waste treatment, *Wetlands treatment, Artificial wetlands, Community development, Management planning, Social aspects, Waste disposal, Wastewater disposal.

Focus is placed on the treatment or disposal of wastewater in natural or constructed wetlands both of which may be able to meet some of a community's wastewater disposal and/or treatment needs. The final determination of the appropriateness of a specific discharge to a specific wetland rests on an individual, detailed site assessment. In this document, a number of factors relevant to the assessment are addressed, which include: (1) the initial background assessment of whether wetlands may be appropriate for meeting a community's wastewater management needs; (2) a summary of the regulations which relate to wastewater discharge to wetlands; (3) an assessment of the quality and quantity of wastewater; (4) an analysis of the wetland values in a community and an evaluation of the wetland's ability to tolerate or treat inflows of wastewater; (5) an outline of the possibilities that constructed wetlands may offer; (6) a presentation on the economics of using constructed or natural wetlands to meet treatment or disposal needs; and (7) a discussion of community wastewater management strategies. (Lantz-PTT)
W91-03014

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR WASTES FROM THE PRODUCTION OF DINITROTOLUENE, TOLUENEDIAMINE, AND TOLUENE DIISOCYANATE, K027, K111, K112, K113, K114, K115, K116, U221, AND U223.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
J. E. Labiosa.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-221527. Price codes: A06 in paper copy, A01 in microfiche. Final Report EPA/530-SW-89-0480, May 1989. 92p, 2 fig, 12 tab, 29 ref, 3 append.

Descriptors: *Best demonstrated available technology, *Industrial wastewater, *Toluenes, *Waste treatment, *Wastewater treatment, Dinitrotoluene, Industrial wastes, Organic compounds, Regulations, Standards, Toluenediamine.

The EPA's treatment standards for toluene constituents are provided in this document, although the EPA is not proposing treatment standards for the newly listed related wastes K111 and K112 at this time. This background document presents waste specific information, the number and locations of facilities affected by the land disposal restrictions for K027, K113-K116, U221 and U223 wastes, the waste generating process, characterization data, and the technologies used to treat the waste or similar wastes. Also explained is the determination of the best demonstrated available technology (BDAT), the selection of constituents to be regulated, and the method used to calculate treatment standards. (Lantz-PTT)
W91-03015

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR WASTES FROM THE PRODUCTION OF CHLORINATED ALIPHATIC HYDROCARBONS F024.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
J. R. Berlow, and J. Vorbach.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-221501. Price codes: A03 in paper copy, A01 in microfiche. Final Report EPA/530-SW-89-048M, May 1989. 122p, 1 fig, 20 tab, 37 ref, 3 append.

Descriptors: *Aliphatic hydrocarbons, *Best demonstrated available technology, *Chlorinated hydrocarbons, *Industrial wastewater, *Wastewater treatment, Dioxins, Furans, Industrial wastes, Metals, Organic carbon, Organic compounds, Standards, Suspended solids.

The EPA is regulating 9 organic constituents and 5 dioxins and furans in F024 nonwastewaters and 9 organic constituents, 2 metal constituents, and 5 dioxins and furans in F024 wastewaters. Treatment standards are being reserved for metal constituents in F024 nonwastewaters. Wastewaters for F024 are defined as wastes containing less than 1% (weight basis) total suspended solids and less than 1% total organic carbon (TOC). Wastes not meeting this definition are classified as nonwastewaters and must comply with nonwastewater treatment standards. Recently, analysis of toxicity characteristic leaching procedure (TCLP) extracts obtained from the stabilization of F024 incinerator ash residues were completed, showing a substantial reduction of metals in TCLP extracts following stabilization. The BDAT treatment standards for dioxin and furan constituents in both F024 nonwastewater and wastewater are set at the analytical detection limit that can be routinely achieved for these constituents, consistent with the dioxins rule promulgated by the EPA. Tables included list specific BDAT treatment standards for F024 and total concentration of organic and metal constituents in F024 wastewaters. (Lantz-PTT)
W91-03016

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR PHTHALATE WASTES.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
R. April, and L. Rosengrant.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-221451. Price codes: A04 in paper copy, A01 in microfiche. EPA Report EPA/530-SW-89-048H, June 1989. 51 p, 2 fig, 11 tab, 13 ref.

Descriptors: *Best demonstrated available technology, *Industrial wastes, *Industrial wastewater, *Phthalates, *Standards, *Wastewater treatment, Organic compounds, Regulations.

This background document provides the US EPA's technical support for selecting and developing treatment standards for the constituents to be regulated in phthalate wastes. Sections 2 through 7 present waste-specific information for the K023, K093, and K094 wastes. Section two presents the number and location of facilities affected by the land disposal restrictions, the waste generating process, and the waste characterization data. Section three presents the technologies used to treat the wastes (or similar wastes). Section 4 presents the available performance data, including data on which the treatment standards are based. Section 5 explains EPA's determination of BDAT, while section 6 discusses the selection of constituents to be regulated. Treatment standards are determined in section 7. Section 8 presents a discussion of the development of treatment standards for those phthalate wastes designated as U wastes (U028, U069, U088, U102, U107, and U190). Six facilities produce phthalic anhydride. The EPA is proposing to regulate one organic constituent in both nonwastewater and wastewater forms of K023, K093, and K094 wastes. (Lantz-PTT)
W91-03017

FINAL, BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR K011, K013, AND K014.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
R. April, and M. Chatman-McEaddy.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-221477. Price codes: A06 in paper copy, A01 in microfiche. Final Report EPA/530-SW-89-048J, June 1989. 104p, 1 fig, 13 tab, 20 ref, 3 append.

Descriptors: *Acrylonitriles, *Best demonstrated available technology, *Industrial wastewater, *Standards, *Wastewater treatment, Cyanide, Incineration, Industrial wastes, Organic compounds, Regulations.

This background document presents the US EPA's technical support for selecting and developing the treatment standards for the constituents to be regulated in acrylonitrile wastewaters. Information is included that is relevant to acrylonitrile wastewaters. Section 2 presents waste-specific information: the number and location of facilities affected by the land disposal restrictions, the waste generating process, and waste characterization data. The technologies used to treat the waste (or similar wastes) are discussed in Section 3. All available performance data, including data on which the treatment standards are based, are presented in Section 4. Section 5 explains EPA's determinations of best demonstrated available technology (BDAT), and Section 6 discusses the selection of constituents to be regulated. The treatment standards are determined in Section 7. The EPA would like to emphasize that it has evaluated all available data in developing the BDAT treatment standards for K011/K013/K014 nonwastewaters. The agency has information indicating that generators of the K013, and K014 listed wastes currently mix them together before treatment and disposal. Consequently, The EPA has developed treatment standards for these wastes as K011/K013/K014 mixed nonwastewaters. The acrylonitrile wastes contain cyanide and BDAT list organic constituents. Rotary kiln incineration was determined to be the BDAT for both the organics and cyanides in the K011/K013/K014 nonwastewaters. Four organic constituents and cyanide in nonwastewater forms of the acrylonitrile wastes are regulated. For BDAT list organics and cyanide, the treatment standards reflect total waste concentration. Testing procedures for all sample analyses performed for the regulated constituents are specifically identified in the appendix. (Lantz-PTT)
W91-03018

INFORMATION COLLECTION REQUEST FOR: PROPOSED NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR SYNTHETIC ORGANIC CHEMICALS.
Miller (Wade) Associates, Inc., Arlington, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-192421. Price codes: A03 in paper copy, A01 in microfiche. April 1989. 28p, 4 exhibits.

Descriptors: *Drinking water, *Regulations, *Synthetic organic compounds, *Water quality, Herbicides, Lindane, Methoxychlor, Monitoring, Organic compounds, Pesticides, Silvex, Toxaphenes.

Synthetic organic chemicals (SOC) are used in the manufacture of a wide variety of industrial and agricultural products. Concern for the industrial use of solvents is focused primarily on the contamination of groundwater from improper disposal. Currently, National Interim Primary Drinking Water Regulations (NIPDWRs) are in effect for five of the SOCs: lindane, methoxychlor, 2,4-D, 2,4,5-TO (silvex), and toxaphene. Compliance monitoring requirements are proposed by EPA for 30 organic compounds, including 10 solvents, 17 pesticides or herbicides, and 3 miscellaneous chemicals: acrylamide, epichlorohydrin, and polychlorinated biphenyls (PCBs). In developing the proposed information collection requirements, the EPA divided the SOCs into two categories: (1) industrial solvents, and (2) pesticides, herbicides and miscellaneous compounds. The EPA is proposing monitoring requirements, but not standards, for other organic chemical contaminants under this rulemaking which would require the collection of information by public water systems, states and the EPA. Information collection requirements include monitoring, reporting and record keeping activities which are presented in this document. (Lantz-PTT)
W91-03019

REGULATORY IMPACT ANALYSIS OF PROPOSED NATIONAL PRIMARY DRINKING WATER FOR SYNTHETIC ORGANIC CHEMICALS.
Miller (Wade) Associates, Inc., Arlington, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-192405. Price codes: A06 in paper copy, A01 in microfiche. April 1989. 108p, 28 exhibits.

Descriptors: *Cost-benefit analysis, *Drinking water, *Regulations, *Synthetic organic compounds, *Water quality, Economic aspects, National Primary Drinking Water Regulations.

National Primary Drinking Water Regulations are proposed for 30 synthetic organic chemicals, termed SOCs. This document presents an analysis of the projected national costs and benefits associated with the proposed regulations in compliance with Executive Order 12291. It also includes an analysis of cost impacts on small water systems in compliance with the Regulatory Flexibility Act. An analysis of occurrence indicates that 30 synthetic organic chemicals (SOCs) fall into three groups or levels which correspond to low, medium, and high 'potential' for groundwater contamination. For a group of 3 miscellaneous contaminants (acrylamide, epichlorohydrin, and PCBs), it was not possible to estimate occurrence due to a lack of data. Total national costs and benefits for all 3 are not anticipated to be very significant. (Author's abstract)
W91-03020

REGULATORY IMPACT ANALYSIS: BENEFITS AND COSTS OF PROPOSED NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR INORGANIC CHEMICALS.
Miller (Wade) Associates, Inc., Arlington, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-192397. Price codes: A06 in paper copy, A01 in microfiche. March 1989. 122p, 34 exhibits.

Descriptors: *Cost-benefit analysis, *Drinking water, *Inorganic compounds, *Regulations, *Water quality, Costs, Economic aspects, Maximum contaminant level, Potable water.

The costs and benefits of controlling inorganic chemical contaminants (IOCs) in drinking water through the promulgation of regulations for maximum contaminant level goals (MCLGs) and maximum contaminant levels (MCLs) were analyzed. A regulatory impact analysis (RIA) was prepared in accordance with Executive Order 12291 which requires that the costs and benefits of all major rules be examined and compared. The major topical areas covered in this RIA are as follows: problem definition; market imperfections, the need for federal regulation, and consideration of regulatory alternatives; assessment of total costs; assessment of benefits; regulatory flexibility and paperwork reduction analyses; and summary of costs and benefits. (Author's abstract)
W91-03021

ECONOMIC ANALYSIS OF PROPOSED AMENDMENTS TO WATER POLLUTION REGULATIONS PHOSPHORUS DISCHARGES R87-6.
Blaser, Zeni and Co., Springfield, IL.
W. L. Blaser, W. R. Rickert, J. L. Carlson, and D. B. Huggins.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-152698. Price codes: A09 in paper copy, A01 in microfiche. Report No. ILENR/RE-EA-8/03, January 1989. 192p, 13 tab, 52 ref. Illinois Department of Energy and Natural Resources Contract EA 59.

Descriptors: *Economic aspects, *Phosphorus, *Regulations, *Water pollution control, Cost-benefit analysis, Costs, Crab Orchard Lake, Illinois, Lake Carlyle, Lake Charleston, Lake Decatur, Lake Shelbyville, Pistakee Lake, Standards, State jurisdiction, Water quality, Water quality control.

An analysis of proposed Illinois statewide regulations to exempt 21 point sources from the requirement to limit total phosphorus in their effluent to 1.0 mg/L is provided. The proposed regulations would provide exemptions to point sources which are more than 25 miles from an impoundment which may have a population equivalent of more than 1500 and less than 2500 or which are tributary to Lake Decatur. Phosphorus is considered to be the limiting nutrient which usually determines the amount of algae, phytoplankton, and macrophytes that grow in bodies of water. Six lakes with treatment plants which would be affected by the proposed regulation are: Crab Orchard Lake, Lake Decatur, Pistakee Lake, Lake Charleston, Lake Shelbyville and Lake Carlyle. Adoption of the proposed exemption would result in increased loadings of phosphorus at each of these lakes. The percentage increases range from 0.4% to 19.4%. The study concludes that the increase in phosphorus loadings at all but Lake Shelbyville would have no measurable effect on aquatic biology. A decline in recreational activity at Lake Shelbyville may have an adverse effect on the local economy. Indications are: (1) that adoption of the proposed regulation would result in benefits exceeding costs for five of the six affected lakes; and (2) that the costs of adoption may be expected to outweigh the benefits for the sixth, Lake Shelbyville. (Lantz-PTT)
W91-03022

ECONOMIC ANALYSIS OF PROPOSED SITE SPECIFIC CHANGES TO WATER QUALITY REGULATIONS AFFECTING BORDEN CHEMICAL COMPANY.
Booker Associates, Inc., St. Louis, MO.
R. B. Pershall, and W. E. Eliot.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-163000.

Price codes: A06 in paper copy, A01 in microfiche. Report No. ILENR/RE-EA-89/07, January 1989. 119p, 7 fig, 12 tab, 25 ref, 3 append.

*Water quality, *Regulations, *Economic aspects, *Industrial wastewater, Dissolved solids, Chlorides, Cost-benefit analysis, Water pollution control, Reverse osmosis, Electrodialysis, Landfills, Injection wells.

Direct and indirect benefits and costs associated with reducing Borden's total dissolved solids (TDS) and cloride discharge concentrations are investigated. Six compliance alternatives involving various combinations of add-on wastewater controls and disposal of the collected waste product were analyzed with regard to feasibility and cost. Environmental threshold levels for TDS and chlorides were determined and used to develop benefits resulting from reduced pollutant concentrations. Modeling indicates that these concentrations would have to be reduced by about 28% to avert water quality violations. The least expensive of the alternatives (reverse osmosis with deep well injection) would probably increase expenditures for environmental controls at the plant from the current level of about $34.2 million to about $35.1 million (net present value of 30 year stream of costs), an increase of 3%. The study found that relatively small monetary benefits could be associated with reduced TDS and Cl discarges to the unnamed tributary because: (1) the improvement in water quality would occur in relatively confined waters whose primary use is as a conduit for industrial discharge and agricultural runoff; (2) other uses of the tributary and its waters are limited; and (3) groundwater users in the vicinity are not in close proximity to the tributary. Direct benefits were assessed under six categories, none of which is affected by choice of compliance alternative. Aggregate (30 year present value) benefits to recreation, aquatic life, health residential water supply, agriculture and aesthetics were estimated to fall in a range of about $42,000 to $125,000. (Lantz-PTT).
W91-03023

40 CFR 265 INTERIM STATUS INDICATOR-EVALUATION GROUND-WATER MONITORING PLAN FOR THE 216-B-63 TRENCH.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 7A.
W91-03024

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT): BACKGROUND DOCUMENT FOR K009 AND K010.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
R. April, and J. Labiosa.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-221469. Price codes: A04 in paper copy, A01 in microfiche. EPA Report EPA/530-SW-89-048I, June 1989. 83p, 1 fig, 9 tab, 24 ref, 3 append.

Descriptors: *Best demonstrated available technology, *Chloroform, *Industrial wastewater, *Regulations, *Waste treatment, *Wastewater treatment, *Water pollution control, Land disposal, Standards.

EPA's technical support for selecting and developing treatment standards for the only regulated constituent (i.e., chloroform) for K009 and K010 wastes are documented. Section 2 of this document presents waste specific information, the number and location of facilities affected by the land disposal restrictions, manufacturing processes generating the wastes, and waste characterization data. Section 3 discusses the applicable and demonstrated technologies used to treat the waste, and Section 4 summarizes the available performance data, including data on which the treatment standards are based. Section 5 explains EPA's determination of best demonstrated available technology (BDAT), while Section 6 discusses the selection of the regulated constituent and deletion of some K009 and K010 constituents originally selected in the proposed rule. Determination of the treatment standards is presented in Section 7. The performance standards for chloroform in K009 and K010 nonwastewaters have been established based on a transfer of the chloroform treatment standard established for K009 wastes and are based on the total concentration analysis of the ash residuals for chloroform generated during incineration of K019 waste. The BDAT level of performance standards for K009 and K010 wastewaters are promulgated based on a transfer of treatment performance data from EPA's Office of Water for wastewaters that are believed to be similar to and/or to contain constituents present in K009 and K010 wastewaters. These data were used to establish the Effluent Limitation Guidelines and Standards for the Organic Chemicals Plastics and Synthetic Fibers Industries. If the concentrations of the regulated constituent, as generated or treated, are lower than or equal to the promulgated BDAT treatment standard, than the wastes are not prohibited from being placed in land disposal units. (Lantz-PTT)
W91-03028

GUIDANCE ON REMEDIAL ACTIONS FOR CONTAMINATED GROUND WATER AT SUPERFUND SITES.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-184618. Price codes: A06 in paper copy, A01 in microfiche. EPA Report EPA/540/G-88/003, December 1988. 98p, 19 fig, 19 tab, 11 exhibits, 6 append.

Descriptors: *Cleanup operations, *Groundwater pollution, *Groundwater quality, *Standards, *Superfund, *Water pollution treatment, Environmental protection, Regulations.

Information is provided that can be used in the process of investigating and assessing remedial actions for contaminated groundwater. The report may be considered a primer on pertinent aspects of groundwater contamination that are important to the development of sound remedies. The goal of Superfund groundwater remediation is to protect human health and the environment by restoring groundwater to its beneficial uses within a reasonable time frame, given the particular site circumstances. The Groundwater Protection Strategy (GWPS) plays an important role in the groundwater remedial action decision making process because the Superfund program generally applies the basic framework outlined in the strategy for protecting groundwater according to its current and future vulnerability, use and value. Before initiating remedial investigation/feasibility study (RI/FS) activities, site management planning should be conducted, and cleanup levels for groundwater must be selected to maintain the groundwater's beneficial uses. If the groundwater is potentially potable, cleanup levels are determined according to health based standards for drinking water. If the groundwater discharges into an aquatic habitat, cleanup levels may be based on those protective of aquatic life. Aggregate effects of multiple contaminants found in groundwater should be assessed to insure that risks do not exceed protective levels. Remedial action objectives are developed after site characterization and specify the area of attainment, the restoration time frame, and cleanup levels. (Lantz-PTT)
W91-03031

WATER: LAWS AND MANAGEMENT.
For primary bibliographic entry see Field 6E.
W91-03032

TWO STATES, TWO POLICIES: WETLANDS AND MINING IN ALASKA AND PENNSYLVANIA.
Pennsylvania State Univ., University Park. Graduate School.
For primary bibliographic entry see Field 6E.
W91-03033

OVERCOMING INSTITUTIONAL BARRIERS AND CONSTRAINTS TO WATER QUALITY MANAGEMENT.
University of Tennessee, Planning Research Center, Knoxville, TN.
G. E. Bowen, and G. E. Ferguson.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 2B-5--2B-16, 5 tab, 4 ref.

Descriptors: *Institutional constraints, *Public policy, *Tennessee, *Water management, *Water quality, *Water quality management, *Water resources management, Economic aspects, Land use, Legal aspects, Regulations, Water pollution control.

Water quality management constraints and barriers include scientific, legal, policy, administrative, land use, and technical dimensions. In order to understand water quality constraints and barriers in Tennessee a delphi process was undertaken in which 30 Tennessee state experts participated. The experts first defined the barriers, and then rated and prioritized them. Finally, they offered alternative solutions to the major barriers which were: (1) economic interests that favor growth and development over environmental protection; (2) the absence of nonpoint source pollution legislation; (3) traditional attitudes towards land ownership and effective land use controls; (4) the inability to enforce existing regulations; and (5) the reluctance of the public to spend money for pollution control measures. The solutions proposed were then rated with regard to the following factors: (1) the impact that the solution would have on the barrier, (2) how effective would the solution be in terms of correcting or eliminating the barrier, and how feasible it is to implement the solution. The two highest rated solutions to the problem of economic interests favoring growth, were: (1) make environmental protection attractive with substantial tax deductions; and (2) work with industries to develop least cost solutions. Regarding the problem of the inability to enforce regulations, the highest rated solutions were: (1) obtain more public support; (2) elect leaders who will enforce regulations; and (3) add more inspection personnel. (See also W91-03032) (Lantz-PTT)
W91-03041

POLICY EDUCATION TO BUILD LOCAL CAPACITY TO MANAGE THE RISK OF GROUNDWATER CONTAMINATION.
Cornell Univ., Ithaca, NY. Resource Economics.
D. J. Allee, and C. W. Abdalla.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 2B-31--2B-40, 1 fig, 6 ref.

Descriptors: *Education, *Groundwater pollution, *Public participation, *Water management, *Water pollution prevention, *Water resources development, Economic aspects, Environmental protection, Governmental interrelations, Research facilities.

Extension education organizations are attempting to develop ways to make water resources participation more rewarding and successful through applying a better understanding of the policy process and the role of information at different stages of public decision making. The Kellogg Foundation is funding a seven state test, applying educational concepts that have proven successful with other, quite different policy topics. Groundwater protection as a policy issue, has characteristics that require an educational approach for solution, and managing the risk of groundwater contamination presents unique demands upon local governance capacity. The diversity of groundwater vulnerability across the landscape, the ubiquitousness of sources of hazard, the stake that local users of the resource have in its protection, the need for face-to-face management relations, and the substantial preemption of land use controls by local governments, all taken together suggest that the States and Federal government should build up their local capacity in this area. But for this to happen, both local and state leaders need policy educational support. Since so many of the groundwater protection questions involve research results and their interpretation, universities, particularly the Land Grants with their Agricultural Experiment

Stations and Water Resource Institutes, should be drawn to this window of opportunity to help create new resource management institutions in response to strong public interest. (See also W91-03032) (Author's abstract)
W91-03043

WATER USE, REUSE AND ABUSE.
General Development Corp., Miami, FL.
For primary bibliographic entry see Field 5D.
W91-03056

DISCHARGE WATER QUALITY OF PERMITTED WET DETENTION SYSTEMS.
Southwest Florida Water Management District, Brooksville.
B. T. Rushton, H. C. Hull, and C. W. Dye.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 8A-1--8A-13, 5 tab, 25 ref.

Descriptors: *Detention reservoirs, *Florida, *Wastewater disposal, *Water management, *Water quality, Dissolved oxygen, Metals, Monitoring, Southwest Florida Water Management District, Suspended solids.

A survey evaluated wet detention ponds permitted by the Southwest Florida Water Management District, by comparing their discharge effluent to state water quality standards. Preliminary results from the first 4 months of a year long study show 29% of the ponds consistently had dissolved oxygen readings below state criteria (4 mg/l), and 17% exceeded standards for total metals. Other parameters measured were within state water quality guidelines. Average total suspended solids values measured in the discharge from the detention ponds during storm events were similar to those noted from efficient sewage treatment plants (<20 mg/l). Algae blooms were common in the ponds for one sampling trip made during a month-long drought in late fall which were associated with increased suspended solids and sometimes heavy metals. (See also W91-03032) (Author's abstract)
W91-03061

ANTIDEGRADATION: A NEW LEVEL OF WATER QUALITY CONTROL. THE COLORADO EXPERIENCE.
Vranesh and Raisch, Boulder, CO.
J. R. Raisch.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 8A-17--8A-22.

Descriptors: *Antidegradation Policy, *Colorado, *Legal aspects, *Regulations, *Water management, *Water pollution control, *Water pollution prevention, *Water quality control, Clean Water Act, Dissolved oxygen, Legislation, Public policy.

The Antidegradation Policy applies where existing water quality levels are better than the water quality standards necessary to protect the use of the water. For example, a stream may have a dissolved oxygen level of 8.0 mg/L. A new discharge or diversion could cause the existing water quality levels to be lowered to 6.0 mg/l, still better than the standard of 5.0 mg/L, but significantly less than the existing quality. The Antidegradation Policy adopted by the US EPA and many of the states could allow water quality to be lowered only after determining that allowing lower water quality is necessary to accommodate important economic or social development. To date, no court has considered whether an antidegradation policy is a necessary component of a state water quality standards program under the Clean Water Quality Act. However, this issue is a major factor in an Environmental Defense Fund lawsuit over Colorado's antidegradation policy. The policy has existed for twenty years without legal review. As a result of the high priority put on antidegradation, EPA has reviewed the antidegradation policies and implementation procedures of the 50 states in late 1988. This review concluded that major problems existed in at least 40 of the states. (Author's abstract)
W91-03062

DESIGN AND LEGALITY OF AN INNOVATIVE APPROACH TO NONPOINT SOURCE CONTROL.
Environmental Defense Fund, New York.
H. Wendel, and D. Dudek.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 8A-23--8A-28, 3 ref.

Descriptors: *Legal aspects, *Management planning, *Nonpoint pollution sources, *Water pollution control, *Water quality control, Colorado, Costs, Dillon Reservoir, Water quality management.

Innovative strategies have been developed to incorporate nonpoint source control in water quality control plans within the current system of legal rights and rules. These strategies involve taking advantage of significant cost gradients that often exist between point and nonpoint source controls. Programs for trading off point source (PS) for nonpoint source (NPS) control have moved successfully from the conceptual to the implementation stage. An example of this is the phosphorous control plan for Dillon Reservoir in Summit County, Colorado. Innovative Waste Load Allocation (WLA) concepts have met with skepticism in the past due to the legal uncertainty believed to be associated with them. One concern relates to any PS emission limit relaxation that may be necessary in implementing an optional PS/NPS strategy. This important concern can be laid to rest in regard to control plans for water quality-limited situations. For such areas, PS/NPS trading strategies meeting antidegradation and antibacksliding requirements can readily be designed. (See also W91-03032) (Author's abstract)
W91-03063

STATE WATER QUALITY LAWS AND PROGRAMS TO CONTROL NONPOINT SOURCE POLLUTION FROM FOREST LANDS IN THE SOUTH.
Georgia Univ., Athens. School of Forest Resources.
F. W. Cubbage, W. C. Siegel, and P. M. Lickwar.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 8A-29--8A-37, 7 ref.

Descriptors: *Forest watersheds, *Legislation, *Nonpoint pollution sources, *State jurisdiction, *Water pollution control, *Water quality control, Best management practices, Federal jurisdiction, Florida, Georgia, Legal aspects, North Carolina, Virginia, Water quality, Water quality management.

Since enactment of the 1972 Federal Water Pollution Control Act Amendments, substantial federal and state efforts have been initiated to control nonpoint source pollution emanating from forest lands. A brief review of the background of federal laws enacted to maintain water quality is presented, along with specific reviews of state water quality statutes and programs that affect forestry in the South. State statutes and programs include general water quality laws that could be construed to apply to forestry practices, specific legislation that addresses silviculture and harvesting, related laws that indirectly affect forested lands, voluntary best management practice (BMP) programs, and financial incentives. The state programs for controlling nonpoint source pollution are summarized, based on the results of a recent survey of southern forestry and lead environmental agencies. State forestry and lead environmental agencies use educational programs to emphasize the value of BMPs to land owners and forest operators. These programs may employ written BMP manuals, workshops or on-site inspections. The states with the most active educational programs in 1987 were Virginia, North Carolina, Georgia, and Florida. Financial incentives are seen as an effective nonregulatory method of encouraging the desired land management practices. In 1987, the thirteen southern states employed a total of 24 personnel, and spent approximately $1 million on forestry-related nonpoint source pollution control. (See also W91-03032) (Lantz-PTT)
W91-03064

LEGAL ISSUES IN SURFACE WATER AND GROUNDWATER HAZARDOUS SUBSTANCES CONTAMINATION CASES.
Huey, Guilday, Kuersteiner and Tucker, Tallahassee, FL.
T. J. Guilday, and R. A. DeMeo.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 7B-7--7B-18.

Descriptors: *Groundwater pollution, *Hazardous wastes, *Legal aspects, *Surface water, *Water pollution control, Legislation, Regulations, Water quality, Water quality control.

US and Florida law is undergoing rapid change with regard to issues related to surface water and groundwater hazardous substance contamination. As advances in science reveal the previously unknown scope of contamination caused by hazardous substances, state, federal, and local regulators responsible for protecting the environment are becoming more active in bringing enforcement actions and law suits to require remediation of contamination. Recent trends include an increase in damages actions by governments and private parties against polluters for environmental damage caused by hazardous substances. In particular, traditional common law has been expanded to attempt to fashion remedies that meaningfully address contamination. Recent trends have included an expansion of tort law to encompass contamination incidents. Practitioners are encouraged to monitor the activities of the Legislature, the government regulators, and the courts as the law continues to evolve in this area. (See also W91-03032) (Lantz-PTT)
W91-03069

NATIONAL EDUCATIONAL PROGRAM IN WASTEWATER TREATMENT FOR SMALL RURAL COMMUNITIES.
Ohio State Univ., Columbus. Dept. of Agricultural Engineering.
K. Mancl.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 9B-7--9B-11, 10 ref.

Descriptors: *Education, *Rural areas, *Waste management, *Wastewater treatment, Kansas, Maryland, Ohio, Oregon, Texas, Wastewater management.

An educational program was conducted in Ohio to teach local officials about wastewater treatment. The five-session workshop covered wastewater treatment alternatives, needs assessment, system management, and resource gathering. The knowledge and skills gained were measured using a pre/post test, and surveys conducted during the workshops. Extension waste management specialists in four states (Maryland, Kansas, Texas, and Oregon) have received training and materials to conduct the workshops in their own states. (See also W91-03032) (Author's abstract)
W91-03072

WATER RESOURCES MANAGEMENT IN A SMALL CENTRAL FLORIDA COMMUNITY: TAVARES, FLORIDA.
Howard, Needles, Tammen, and Bergendoff, Orlando, FL.
T. R. Sear.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 12A-19--12A-26, 1 tab.

Descriptors: *Florida, *Local governments, *Project planning, *Storm water management, *Wastewater treatment, *Water pollution control, *Water resources management, Tavares, Water quality control, Water resources development, Wetlands.

The City of Tavares is a small Central Florida community of approximately 7,300 people, located in Lake County. The city is fortunate to be located adjacent to three major lakes and contain within its borders numerous small water bodies and wetland

areas, contributing to its accelerated growth in recent years. The City began a program of stormwater management in the Fall of 1986 with the creation of a Stormwater Management Committee. The committee assisted the City in the creation of a Stormwater Utility that began operation in the Fall of 1987. The utility has since funded the hiring of two full-time maintenance workers, and the completion of a Master Stormwater Management Study. The City is now conducting a positive program of stormwater facility maintenance, wetland purchase, water quality monitoring, and facility construction, which will allow them to better preserve their water resources in the future. Water resources preservation at the local level can only succeed when a long-term commitment is made to maintenance, monitoring, stormwater management, and wetland preservation. To their credit, the City of Tavares has made this commitment to their future. (See also W91-03032) (Lantz-PTT)
W91-03078

MODELING THE HYDROLOGIC IMPACTS OF PHOSPHATE MINING AND RECLAMATION IN CENTRAL FLORIDA.
Bromwell and Carrier, Inc., Lakeland, FL.
For primary bibliographic entry see Field 4C.
W91-03082

SILVICULTURE BEST MANAGEMENT PRACTICES-A COMPREHENSIVE ASSESSMENT.
Florida Div. of Forestry, Tallahassee.
B. W. Gay, and T. E. Demott.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 14A-1--14A-7, 3 ref.

Descriptors: *Best management practices, *Forestry, *Silviculture, *Water pollution control, *Water resources management, Florida, Forest management, Forest watersheds, Land use, Steinhatchee River Basin.

Silviculture Best Management Practices (BMPs) have been the primary tool to prevent nonpoint pollution associated with forestry operations. These practices are viewed as voluntary in Florida if satisfactory compliance continues. The State's water quality agency designated the Florida Division of Forestry (DOF) as the lead agency responsible for assessing compliance. To address this charge, the DOF has conducted biennial compliance surveys since 1981. A more intensive watershed survey has also been conducted in the Steinhatchee River basin. The survey consists of aerial site identification followed by on-the-ground inspections. A comprehensive questionnaire addresses each aspect of the timber operation with emphasis on access systems, site preparation techniques, and harvesting procedures. These inspections are conducted with the land manager and provide a valuable educational opportunity. To date, results from past surveys reflect a favorable level of compliance. In addition, these results provide useful information for targeting geographic areas in need of assistance and identifying specific practice needs. The survey technique has proven successful and will be valuable for addressing concerns pertaining to other specific watersheds, to other areas in which management guidelines are used, and to support land use options available to landowners. (See also W91-03032) (Author's abstract)
W91-03083

DEVELOPMENT OF MANAGEMENT STRATEGIES FOR BARATARIA BASIN, LOUISIANA.
Louisiana Geological Survey, Baton Rouge.
R. D. Hartman, and D. R. Cahoon.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 14B-33--14B-47, 5 fig.

Descriptors: *Barataria Basin, *Coastal zone management, *Louisiana, *Management planning, *Water quality, *Water resources management, *Wetlands, Diversion, Estuaries, Land use, Marshes, Shore protection, Tertiary wastewater treatment.

Technical recommendations concerning the management of the quality of coastal environments in Barataria Basin, Louisiana were developed from a review of strategies used in other states to preserve estuarine areas, combined with management recommendations developed for the Basin by a multidisciplinary advisory group of research managers. Wetland loss, hydrologic isolation, water quality, human and cultural resources, and economic development were identified as the primary issues affecting the Basin. The Basin was divided into 4 management units based on hydrologic isolation, marsh type and environmental problems. Specific problems and critical areas in each unit were identified, and water and land management objectives were established for each unit. Management recommendations pertinent to all units were delineated first, and include the reduction of canalization impacts, the use of wetlands for tertiary waste treatment, reducing effects of produced water discharges, and freshwater diversion. Recommendations specific to management areas include specific sites for freshwater diversion, water control structures and shoreline stabilization plans. (See also W91-03032) (Author's abstract)
W91-03095

SOUTHWEST FLORIDA MANAGEMENT DISTRICT SAVE OUR RIVERS PROGRAM.
For primary bibliographic entry see Field 4A.
W91-03096

BIOTREATMENT: THE USE OF MICROORGANISMS IN THE TREATMENT OF HAZARDOUS MATERIALS AND HAZARDOUS WASTES.
For primary bibliographic entry see Field 5D.
W91-03097

METABOLIC DIVERSITY OF MICROBIAL BTEX DEGRADATION UNDER AEROBIC OR ANOXIC CONDITIONS.
Michigan Univ., Ann Arbor. Medical Center.
For primary bibliographic entry see Field 5D.
W91-03099

BIODEGRADATION OF PCP CONTAMINATED SOILS USING IN SITU SUBSURFACE BIORECLAMATION.
Keystone Environmental Resources, Inc., Monroeville, PA.
J. R. Campbell, J. K. Fu, and R. O'Toole.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 17-27, 14 fig, 5 tab.

Descriptors: *Biodegradation, *Cleanup operations, *Groundwater pollution, *Pentachlorophenol, *Soil contamination, *Water pollution treatment, Aerobic conditions, Anaerobic conditions, Bioremediation, Leaching, Microbial degradation.

An evaluation of in situ subsurface bioremediation was conducted at a manufacturing site that had contaminated nearby soil and groundwater with pentachlorophenol (PCP). Laboratory bench scale tests showed that PCP can be biologically transformed under either aerobic or anaerobic conditions. Mass balance tests performed after a 12 week period showed that approximately 10-20% of the total PCP mass leached out from the soil and 80-90% of the PCP mass was reduced as a result of biological degradation. A remediation plan was developed for pilot scale testing of an in situ biodegradation treatment system. Soil borings were made to test baseline levels of PCP, purgeable aromatics, total organic carbon, oil and grease, and percent solids. The in situ pilot testing was monitored to evaluate immobilization/biodegradation, leaching, and contaminant migration. The degree of success of the in-situ groundwater/soil treatment system depended on the hydrogeologic conditions of the site, the physical and chemical characteristics of the soil and geology, and the characteristics of the chemicals to be biodegraded. The in situ biodegradation/immobilization of chemicals of interest associated with site soils and groundwater was achieved through anaerobic treatment. Groundwater was continually recycled through the subsurface environment (unsaturated and saturated soil) via recovery wells and recharge trenches. After 6-months of operation, soil borings showed PCP reductions of 98, 98, and 51% in soil depths of 4-6 feet, 30-32 feet, and 32-36 feet, respectively. Above grade groundwater treatment consisting of soluble metals removal, UV/ozone chemical oxidation for removal of organic constituents and tertiary treatment with activated carbon adsorption was applied before discharge of pumped groundwater to the leach field. A 99% removal of PCP from groundwater was achieved prior to discharging to the subsurface environment. (See also W91-03097) (Geiger-PTT)
W91-03100

UPDATE ON IN SITU BIOREMEDIATION OF THE FRENCH LIMITED SUPERFUND SITE.
ENSR-Celgene, Inc., Houston, TX.
R. E. Woodward, and D. K. Ramsden.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 29-32, 2 fig.

Descriptors: *Biodegradation, *Bioremediation, *Cleanup operations, *Hazardous waste disposal, *Soil contamination, *Water pollution treatment, Aeration, Bioassay, Microbial degradation, Organic pollutants, Priority pollutants, Sludge disposal, Toxicity.

Following four laboratory feasibility studies and two on-site, scaled-up, 20,000-gallon bioreactor studies, in situ bioremediation was demonstrated in a 0.5 acre cell of the French Limited Site Lagoon. The 6-month demonstration used wastewater treatment technologies related to aerobic biosludge degradation, together with regular toxicity analysis of the aqueous phase. Sludge volume was reduced >85% during the first two treatment phases. The concentration of specific organic priority pollutants in the volatile and semi-volatile group decreased dramatically. Removal kinetics were consistent with activities in each of the four treatment phases. Overall toxicity, as monitored by the Microtox bioassay, decreased significantly. Soluble chloride and sulfate increased approximately five-fold indicating effective dehalogenation and degradation of organochloride and sulfur-containing organics, respectively. The successful in situ demonstration enabled EPA Region 6 to conclude that bioremediation was the preferred technology for site remediation. EPA subsequently issued a Record of Decision for in situ bioremediation. The PRP Task Group signed a Consent Decree outlining a remedial action program. Post-demonstration tasks included a 12-month equipment evaluation phase to optimize sludge materials handling. The remedial action program defined in situ biological treatment of contaminated soils and sludges, installation of a flood control wall around the lagoon perimeter, and backfilling the lagoon to grade. This represented a landmark project for in situ bioremediation and has established precedence for use of this technology at CERCLA and RCRA sites nationwide. (See also W91-03097) (Geiger-PTT)
W91-03101

BENCH-SCALE STUDY OF THE REMOVAL OF CHROMIUM AND CYANIDE FROM CONTAMINATED GROUNDWATER.
E. Goldman, M. Weekes, and A. Fischer.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 33-39, 11 fig, 1 tab, 9 ref.

Descriptors: *Chemical precipitation, *Chromium, *Cleanup operations, *Cyanide, *Groundwater pollution, *Ion exchange, *Water pollution treatment, Catalysts, Filtration, Separation techniques.

Bench-scale (batch and continuous-flow) tests were conducted on polluted groundwater in the vicinity of the Riverbank Army Ammunition Plant (RBAAP), Riverbank, California to determine the feasibility of reducing the cyanide and chromium concentrations to less than 20 micrograms/L. The most promising treatment process determined in the batch screening tests was further evaluated in the continuous-flow tests. The process selected as optimum for the RBAAP site application was chromate reduction with ferrous sulfate, pH adjustment, and precipitation for chromium removal, followed by filtration and ion exchange for cyanide removal. The <20 microgram/L treatment level goals were obtained in this bench-scale treatment system which employed a novel use of nickel and cobalt catalysts and removed chromium and cyanide in a single process train. A full-scale treatment system is being designed and constructed based on this study. (See also W91-03097) (Author's abstract)
W91-03102

REMOVAL OF HEAVY METAL IONS FROM GROUNDWATERS USING AN ALGAL BIOMASS.
Bio-Recovery Systems, Inc., Las Cruces, NM.
D. W. Darnall, and L. D. Hyde.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 41-45, 3 fig, 5 ref.

Descriptors: *Adsorption, *Algae, *Groundwater pollution, *Heavy metals, *Wastewater treatment, *Water pollution treatment, Biofilters, Biomass, Cadmium, Copper, Lead, Mercury, Nickel, Separation techniques.

Advantage was taken of the strong affinity of algal cells for heavy metal ions to produce a material for removing heavy metal ions from contaminated groundwaters. Various species of non-living algae were immobilized in a polymeric matrix and processed into a granular material which was packed into columns through which waters containing heavy metals were passed. Heavy metal ions were adsorbed to the algal matrix, which when saturated, can be stripped of the heavy metal ions allowing reuse of the matrix. The algal-based material has three distinct advantages over precipitation and ion exchange technologies for heavy metal removal: (1) it functions well for heavy metal recovery even when calcium and magnesium are present in concentrations over 10,000 ppm; (2) organic materials do not interfere with the binding of heavy metal ions; and (3) it is capable of recovering heavy metal ions down to levels in the parts per billion range. The algal-based metal adsorbent was effective for removal of copper, cadmium, mercury and other heavy metal ions from a diversity of groundwaters including Superfund sites. Demonstration of the technology is being verified under the U.S. Environmental Protection Agency's Emerging Technology Program Evaluation (SITE) program. (See also W91-03097) (Author's abstract)
W91-03103

PILOT-SCALE BIOREMEDIATION OF CHLORINATED SOLVENT AND PNA-CONTAINING SOILS.
Monsanto Chemical Co., St. Louis, MO.
B. S. Yare, W. J. Adams, and E. G. Valines.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 47-50, 5 fig, 1 ref.

Descriptors: *Biodegradation, *Bioremediation, *Chlorinated hydrocarbons, *Cleanup operations, *Organic pollutants, *Polycyclic aromatic compounds, *Site remediation, *Soil contamination, *Water pollution treatment, Biological wastewater treatment, Hazardous wastes, Organic solvents, Pilot plants, Superfund, Texas, Waste dumps.

A slurry-phase biodegradation demonstration was undertaken to determine if biodegradation could be used to achieve the required treatment levels at the Brio Refining Superfund site located in Harris County, Texas. The impoundments at the site contained styrene and vinyl chloride still bottoms that were to be reprocessed into jet fuel. Samples of affected material and soil were collected from each of the six pits whose entire contents required treatment. Two batches of 30% solids slurry were made using affected material and soil from each of the six pits. One batch was a high carbon batch that included all of the soil, sludges and organic liquids encountered in the pit. The second batch, called the low carbon batch, included only pit cover soil, clay backfill and subsoil. The high carbon and low carbon batches from each pit were run simultaneously using two continuously-stirred, aerated bioreactors. Batches were run for about ten days at ambient temperatures. Of the twelve batches run, all but one met the required treatment requirements after ten days of treatment. The one batch that did not meet treatment requirements appeared to be the result of the inhibition of biological activity. The results of this pilot-scale demonstration indicated that biodegradation is a feasible treatment method for nearly all of the affected material and soil found at the Brio Refining site. (See also W91-03097) (Geiger-PTT)
W91-03104

BIOLOGICAL CLEANUP OF EXTENSIVE PESTICIDE CONTAMINATION IN SOIL AND GROUNDWATER.
Societe de Chimie Industrielle, Paris (France).
H. S. Borow.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 51-56, 4 fig, 3 tab.

Descriptors: *Biodegradation, *Bioremediation, *Cleanup operations, *Groundwater pollution, *Pesticides, *Soil contamination, *Water pollution treatment, Activated carbon, Biological wastewater treatment, Microbial degradation.

In 1987, a fire at a major agricultural warehouse was extinguished with water spreading pesticides into the surrounding soil, groundwater and a nearby creek. Soil and groundwater bioremediation was performed at the site which involved extensive material handling, soil and material segregation, and the use of several biological techniques. An onsite five-acre, clay-lined treatment bed was constructed, mobile bioslurry and liquid-phase bioremediation units were delivered to the treatment location. Contaminated soil from the burn site and along the length of the contaminated creek was excavated and transported to the treatment location. The soil was tested for contaminant levels, separated according to the extent of contamination, and prepared for treatment by the removal of rocks and debris. Solid-phase biotreatment of approximately 12,000 cubic yards of less contaminated soil (containing < 200 parts per million (ppm) of contaminants) was performed on the five-acre lined treatment bed. The soil was processed daily and a microbial inoculum was applied to enhance biological breakdown of the contaminants. A mobile soil slurry bioreactor system was used to treat soils with contamination > 200 ppm. This process consisted of aerobic treatment of soil mixed with water in 26,000 gallon bioreactor tanks. The slurry mixture was inoculated with pesticide-degrading bacteria and with nutrients that optimize the ability of bacteria to degrade the contaminants. Groundwater was treated with granular activated carbon and an innovative in situ bioremediation technique which reduced the treatment time by 50%. An upgradient injection gallery was established to flush treated water and nutrients, as required, through the contaminant plume. During treatment, the groundwater was monitored to guard against off-site migration. During the winter of 1987, more than five million gallons of groundwater were treated. The site was restored to its original condition and a site closure plan prepared in accordance with appropriate regulations. (See also W91-03097) (Geiger-PTT)
W91-03105

FIELD DEMONSTRATION OF A FORCED AERATION COMPOSTING TREATMENT FOR COAL TAR.
C.A.A. Bioremediation Systems, Boston, MA.
A. Taddeo, M. Findlay, M. Dooley-Danna, and S. Fogel.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 57-62, 2 fig, 6 tab, 14 ref.

Descriptors: *Aeration, *Biodegradation, *Coal tars, *Composting, *Hazardous waste disposal, Aerobic treatment, Bioremediation, Polycyclic aromatic compounds, Soil contamination.

The feasibility of using composting for on-site treatment of soils contaminated with coal tars was tested in laboratory compost microcosms using naturally-occurring bacteria. Subsequently, a field demonstration of a static pile forced aeration compost system was designed and operated to treat soil contaminated with tar. A seven cubic yard, stainless steel, mobile composting vessel was constructed and staged at an operating utility company which was a former coal gasification plant. Operation involved maintenance of oxygen, moisture, and mineral nutrient concentrations, as well as recirculation and analysis of leachate and off-gases. Analysis of compost samples indicated that approximately 94% of the total hydrocarbons were degraded, including 84% of priority pollutant polynuclear aromatic hydrocarbons and 95% of the major aromatic tar constituents. The results demonstrate that this technology has high potential for use at hazardous waste sites for biologically treating coal tar wastes. (See also W91-03097) (Author's abstract)
W91-03106

BIOREMEDIATION OF HEAVY PETROLEUM OIL IN SOIL AT RAILROAD MAINTENANCE YARD.
A. Ying, J. Duffy, G. Shepherd, and D. Wright.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 63-68, 7 fig, 2 tab.

Descriptors: *Biodegradation, *Bioremediation, *Cleanup operations, *Oil spills, *Soil contamination, *Water pollution treatment, Microbial degradation.

The biodegradation performance of heavy engine oil in soil at a railroad maintenance yard was investigated using actual oil-containing soil from a northern California rail yard. The oil on the site was heavy engine oil in the C-22+ molecular weight range. The soil was divided into over 130 model ecosystems (microcosms) where multiple combinations of treatment reagents were tested. The treatment inocula included different primary and secondary nutrients, trace metallic elements, booster proteins, various types of biodegradable surfactants and specific oil-degrading microorganisms isolated from the chosen rail yard. Each treatment combination was conducted in quintuplet for statistical purposes. The microcosms were incubated up to a period of 16 weeks. Soil samples were extracted at regular intervals and analyzed for petroleum hydrocarbon via EPA method 418.1. The degradation results were compiled and analyzed for statistical-significance performance (more than 95% certainty) for the various treatment combinations. The data revealed a degradation of up to 94% is possible (in a 16 week period) for heavy petroleum oil in concentrations up to 13,000 ppm in soil. Lower degradation performance was achieved with soil containing up to 3.5% oil. The project is now in the field demonstration phase. (See also W91-03097) (Author's abstract)
W91-03107

AIR STRIPPING/BIOREMEDIATION OF CHLORINATED HYDROCARBONS AT AN NPL SITE.
ECOVA Corp., Redmond, WA.
J. A. Cioffi.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 69-74, 3 fig, 7 tab.

Descriptors: *Air stripping, *Aromatic compounds, *Bioremediation, *Chlorinated hydrocarbons, *Groundwater pollution, *Organic pollutants, *Wastewater treatment, *Water pollution treatment, *Water treatment, Biodegradation, Biological wastewater treatment, Bioreactors, California, Fermentation, Microbial degradation.

Groundwater contaminated with chlorinated hydrocarbons, soluble organic materials, aromatic compounds, ketones, alcohols and glycols at a National Priority List site in California is being treated by a two-step process of air stripping used in conjunction with a bioreactor. Objectives used in selecting this system include onsite destruction of contaminants, minimization of long-term liability, and cost-effectiveness of the system. The combination of physical and biological techniques was effective in resolving the complex groundwater contamination problem at the facility. A mobile modular fermentation unit with temperature, oxygen, agitation, and pH controls was transported to the site. The fermentation unit was inoculated with the prepared consortium of microorganisms into a basal medium with target contaminants as a source of carbon and energy. Following a 5-day fermentation period in which the removal rates of the target organic contaminants were comparable to those observed in laboratory studies, the 150-gallon suspension was inoculated into a bioreactor containing 2,500 gallons of the contaminated groundwater. After an initial 10-day inoculation period, the bioreactor was run at a continuous 5 gallons per minute (gpm). The bioreactor was monitored daily for removal of the target contaminants. As the level of contaminants approached the discharge limits, the flow rate was increased form 5 gpm to 15-18 gpm. Upon meeting the required discharge requirements for all contaminants, the bioreactor was placed in continuous flow/discharge mode. The system was put on continuous discharge to the storm sewer under a NPDES permit in July 1987, after sample results proved that contaminant levels were consistently reduced below discharge limits at a process flow rate of 18 gpm. (See also W91-03097) (Author's abstract)
W91-03108

MANAGING GOVERNMENT REGULATION AND PUBLIC PERCEPTION OF BIOTECHNOLOGY FIELD TESTS: A CASE STUDY.
BioTechnica Agriculture, Inc., Cambridge, MA.
D. J. Glass.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 93-97.

Descriptors: *Biological treatment, *Biotechnology, *Genetic engineering, *Public relations, *Water pollution control, Case studies, Public opinion, Regulations, State jurisdiction.

Biotreatment projects may be affected by the Environmental Protection Agency's proposed approach to regulating biotechnology under the Toxic Substances Control Act (TSCA). This proposal could affect the use of certain naturally occurring or genetically engineered microorganisms in the environment, even at the research stage. Such regulation or possible parallel oversight by state and federal governments, could place even preliminary pilot bioremediation projects under increased public scrutiny, which could create public concern or opposition in local communities. Both the regulatory process and the community's interest in biotechnology activities can be managed effectively by appropriately-planned corporate programs which include guidelines for informing state agencies well in advance of field test plans in each state as well as community relations programs to inform the local citizens of the plans. A program for improved public relations regarding biotechnology projects was designed according to the following principles: (1) openness and honesty with the public about all aspects of the test and the review process; (2) the community, through its elected leaders, would learn of all developments from the source, rather than from the press or from rumors; (3) representatives would always be available to provide information and answer questions. In the case of biotreatment projects, where the hypothetical risks of engineered microorganisms will be weighed against the tangible, ongoing risks associated with the wastes needing treatment, it should not be difficult to gain public acceptance for such biotreatment projects using the proposed guidelines. (See also W91-03097) (Geiger-PTT)
W91-03111

BIODEGRADATION OF XENOBIOTICS BY SPECIFIC BACTERIA: RESEARCH AND APPLICATIONS.
Groningen Rijksuniversiteit (Netherlands). Dept. of Biochemistry.
For primary bibliographic entry see Field 5D.
W91-03113

MONITORING POPULATIONS OF 4-CHLOROBIPHENYL-DEGRADING BACTERIA IN SOIL AND LAKE WATER MICROCOSMS USING COLONY HYBRIDIZATION.
Tennessee Univ., Knoxville.
J. Packard, A. Breen, G. S. Sayler, and A. V. Palumbo.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 119-125, 2 fig, 1 tab, 18 ref. U.S. Air Force Contract F49620-89-C-0023. DOE Contract DE-ACOR21400.

Descriptors: *Bacteria, *Biodegradation, *DNA, *Monitoring, *Polychlorinated biphenyls, *Population dynamics, *Water pollution treatment, Lysimeters, Microbial degradation.

Population dynamics and maintenance of 4-chlorobiphenyl (4CB)-degrading bacteria, Alcaligenes eutrophus, added to field lysimeters and lake water microcosms were monitored by colony hybridization. Six field lysimeters containing soil from a PCB-contaminated floodplain were watered and stirred during the experiment and monitored for 1 yr. At the start of the experiment, half of the lysimeters were inoculated with A. eutrophus. The lysimeters differed in treatments over the year; some received inorganic nutrients and yeast extract and one also received biphenyl. Four 20-L microcosms were set up with water from Fort Loudon Reservoir and were supplemented with mineral salts and glucose and stirred and monitored for 2 months. A. eutrophus was inoculated into 2 of the microcosms, 1 of which was maintained with selective pressure by the addition of 4CB. One of the uninoculated microcosms also had selective pressure for 4CB-degrading organisms. A. eutrophus contains a plasmid, pSS50, which codes for a 4CB degradation pathway. Colony hybridization using the pSS50 plasmid as a probe indicated the plasmid was maintained in the inoculated lysimeters throughout the experiment. An uninoculated lysimeter which had been maintained with inorganic nutrients and yeast extract also maintained a population of 4CB-degrading bacteria which hybridized with the probe. In the lake water microcosms, the pSS50 plasmid was maintained throughout the experiment in both inoculated microcosms; it was found in higher numbers in the microcosm which received selective pressure. The uninoculated microcosm without selective pressure did not demonstrate any pSS50 plasmids above the detection limit of the colony hybridization. The uninoculated microcosm which received selective pressure maintained pSS50 plasmids throughout the experiment. The DNA probe technique was an effective monitoring tool in soil and water samples and indicated the long term survival of bacteria containing the pSS50 (PCB-catabolic) plasmid in field lysimeters and lake water microcosms. (See also W91-03097) (Author's abstract)
W91-03114

BIODEGRADATION OF AN OILY BILGE WASTE USING ALGAE.
GHR Engineering Associates, Inc., Lakeville, MA.
M. Carpenter, J. Robertson, and P. Skierkowski.
IN: Biotreatment: The Use of Microorganisms in the Treatment of Hazardous Materials and Hazardous Wastes. Proceedings of the 2nd National Conference, November 27-29, 1989, Washington, DC. Hazardous Materials Control Research Inst., Silver Spring, Maryland. 1989. p 141-150, 5 fig, 6 tab, 26 ref.

Descriptors: *Algae, *Biodegradation, *Bioremediation, *Oil spills, *Phenols, *Water pollution treatment, Aquatic bacteria, Cleanup procedures, Fate of pollutants, Fungi, Microbial degradation, Mineralization, Yeasts.

A mixed community of microorganisms was collected from the harbor at the San Diego Navy Base and was monitored in a test ecosystem containing an oily bilge waste obtained from off-loading ships. The cultures were examined in the presence and absence of the algae. It was thought that the algae might enhance the degradation of the oily waste by providing oxygen and possibly a nutrient source from dying phytoplankton for the bacterial community. Test ecosystems were subjected to a radiolabeled 14C-phenol and bilge waste mixture to ascertain the ability of the communities to mineralize the phenol and/or assimilate the labeled hydrocarbon. The community containing the algae started mineralizing the phenol (measured by 14CO2 production) 24 hr after exposure to the waste/phenol mixture. The bacteria/yeast-fungi community had a lag period of 384 hr before extensive catabolism of the labeled compound occurred. Current data indicates algae may enhance the biodegradation rate of oily bilge wastes in a mixed microbial community. (See also W91-03097) (Author's abstract)
W91-03116

SPATIAL SIMULATION TO AID IN EVALUATING AND TREATING EROSION AND WATER QUALITY PROBLEMS AFFECTING LAKE ERIE.
Purdue Univ., Lafayette, IN. Dept. of Agricultural Engineering.
D. B. Beasley.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 566-573, 4 tab, 1 fig, 9 ref.

Descriptors: *Agricultural runoff, *Erosion control, *Eutrophication, *Lake Erie, *Model studies, *Phosphorus runoff, *Simulation, *Water pollution control, International agreements, Nutrient inputs, Sediment yield, Tillage.

Lake Erie, by far the shallowest of the Great Lakes, has one of the highest proportions of agricultural drainage. For years, eutrophication and chemical pollution have plagued the lake, but efforts to remove or alleviate municipal and industrial sources of waste have been reasonably successful. Aquatic life has been returning to normal levels. However, the extensive drainage area devoted to agriculture provides a large amount of nutrients to an already eutrophic body of water. The Tri-State Tillage Project aims to demonstrate and assess the application of various levels of conservation tillage on a variety of crops and soils in the Maumee, Portage, and Sandusky River Basins of Ohio, Indiana, and Michigan. Part of the project included estimation of erosion and nutrient yield levels using computer simulation techniques. The model used was ANSWERS (Areal Nonpoint Source Watershed Environment Response Simulation), which is an event-oriented model developed at Purdue University. Sediment and phosphorus yields were predicted for eight different management scenarios. Sediment yields ranging from 40 to

2,370 kg/ha and P yields from 0.03 to 3.50 kg/ha were predicted using this model. The simulations indicate that several scenarios would achieve reasonable reductions without extreme changes in management. However, unless no-till is used on all cropland, reductions approaching 50% and more will be achieved only with a mixture of tillage and structural best management practices (terraces, sediment basins, waterways, etc.). According to simulation results, using no-till on 50% of the group 2 soils (by far the greatest contributors of the eight soil groups recognized) would reduce annual delivery of phosphorus from the study area to Lake Erie by almost 1800 metric tons. Because the simulated sediment and P yields might be as much as 50% higher than average annual values, the reduction might be as small as 1,200 metric tons of P. This figure is still a very large portion of the 1,600-2,000 metric tons goal of the international agreement between Canada and the United States for reducing sediment and nutrient loads. (See also W91-03117) (Rochester-PTT)
W91-03164

GROUNDWATER POLLUTION PROTECTION: A MULTIDISCIPLINARY ACTION TO BE LED BY A PRACTISING HYDROGEOLOGIST AND BACKED UP BY AN ENFORCEMENT OF LAW.
Lille-1 Univ., Villeneuve d'Ascq (France). Lab. d'Hydrogeologie.
N. Crampon.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 243-260, 53 ref.

Descriptors: *Developing countries, *Groundwater management, *Groundwater pollution, *Water pollution control, *Water pollution prevention, *Water resources development, *Water resources management, Field tests, Geohydrology, Hydrologic models, Management planning, Model studies, Path of pollutants, Rehabilitation, Solute transport, Water quality control.

Many developed countries are experiencing industrial pollution and their rural areas are becoming increasingly contaminated by nitrate. Drinking water is becoming scarcer and more expensive. Current heavy growth in developing countries is followed by water supply and sanitation requirements. Fighting groundwater pollution requires a proper knowledge of polluting activities, of their localization and of contaminant behavior with exchange and transport processes in the unsaturated and saturated subsurface. Pollution is a water quality alteration propagated into a special context. This has to be studied on geological, hydrogeological, and hydrogeochemical levels. Monitoring networks and mapping allow specification of the source, the displacement and the distortion of the contaminant plume. to predict the concentration variation over distance and time, models fitted to field data (especially tracer tests) need to be used. Finally, pollution-prevention requires adequate provisions to be made and applied. Pollution removal is always more difficult and more expensive than prevention, in spite of a few rehabilitation processes that are now being developed. The hydrogeologist is the keystone of the battle against groundwater pollution by representing the link between the scientists in the various fields that must be applied to hydrogeological conditions and by suggesting adapted means of study, control and intervention. (See also W91-03178) (Fish-PTT)
W91-03193

GROUNDWATER CONTAMINATION: PROCESSES, CHARACTERIZATION, ANALYSIS, AND REMEDIATION.
GeoTrans, Inc., Herndon, VA.
J. W. Mercer, D. A. Griffin, J. C. Herweijer, and P. Srinivasan.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 261-282, 5 fig, 3 tab, 36 ref.

Descriptors: *Cleanup, *Groundwater management, *Groundwater pollution, *Path of pollutants, *Site remediation, *Water pollution treatment, *Water resources management, Advection, Groundwater movement, Groundwater transport, Hydraulic conductivity, On-site data collections, On-site investigations, Water resources development.

The ultimate goal at a site involving groundwater contamination is remediation. To properly remediate a site, however, an understanding of the controlling processes is necessary. This requires site characterization and analysis of the resulting data. At many sites, the primary mode of transport is advection. Therefore, characterizing the groundwater flow system (i.e., hydraulic conductivity and hydraulic gradient) is critical to understanding the contamination distribution. Other important processes include sorption, chemical and biological reactions, and hydrodynamic dispersion. Sorption and reactions affect remediation. Desorption increases the time required to remediate, whereas chemical and biological reactions can aid remediation (e.g., bioreclamation). For problems involving groundwater contamination, the current practice of remediation involves some form of pump-and-treat technology. Depending on the controlling processes, this technique generally requires long time frames (10-100 years). Therefore, current research examines innovative technologies such as bioreclamation, fixation, soil venting, and in situ heating. (See also W91-03178) (Author's abstract)
W91-03194

SCUDDER'S POND RESTORATION PROJECT FOR VILLAGE OF SEA CLIFF AND TOWN OF OYSTER BAY, NASSAU COUNTY, NEW YORK.
Envirodyne Engineers, Inc., New York.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-217228. Price codes: A04 in paper copy, A01 in microfiche. Final report, January 1982. 69 p, 13 fig, 8 tab, 3 ref, 3 append.

Descriptors: *Eutrophication, *Habitat restoration, *Lake restoration, *New York, *Water quality, *Watershed management, Dredging, Nutrients, Scudders Pond, Sedimentation, Species diversity, Urbanization.

Residential development in the watershed of Scudder's pond in Oyster Bay, Long Island, New York, starting in the 1950s, has been cited as the prime reason for increased sedimentation and subsequent eutrophication, reducing it to one-half its normal size. A water quality monitoring program was initiated at Scudder's Pond several months prior to dredging. Nutrient concentrations indicated eutrophic conditions before, during, and after dredging. Biological and water quality data for the pre-dredging condition of Scudder's Pond indicate the condition to be one of limited habitat and 'stress' in terms of potential for diverse aquatic life. Sufficient qualitative and semi-quantitative information is available from the studies to indicate that the dredging program has effected some improvement in the pond's condition. Information indicating such an improvement includes: increased plankton diversity; reduced predominance of blue-green algae; post-dredging presence of a relatively large Cryptomonas population (generally accepted as indicative of conditions in which organic decomposition has been completed and a water body can be considered 'clean'); and physical removal of a significant quantity of organic-laden sediments from the pond. The pond remains, however, a water body with insufficient depth to provide for seasonal turnover, limited habitat diversity, and probable high nutrient input, based on watershed land use and drainage patterns. Whether or not the pond has been converted to a self-sustaining viable ecosystem remains to be seen. (Fish-PTT)
W91-03218

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR CYANIDE WASTES.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
R. April, and M. Chatmon-McEaddy.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-221485. Price codes: A14 in paper copy, A01 in microfiche. Report no. EPA/530-SW-89-0484, June 1989. 317 p, 10 fig, 63 tab, 73 ref, 3 append. Contract no. 68-01-7053.

Descriptors: *Administrative regulations, *Best available technology, *Cyanide, *Industrial wastewater, *Metal-finishing wastes, *Waste treatment, *Water pollution treatment, *Water quality standards, Chemical precipitation, Electroplating, Filtration, Heat treatment, Metals, Performance evaluation, Sludge drying, Waste characteristics, Wastewater oxidation, Wastewater treatment.

The Environmental Protection Agency (EPA) is promulgating treatment standards based on best demonstrated available technology (BDAT) for cyanide-containing electroplating and metal heat treating wastes and for commercial chemical product wastes. The waste characterization data available to the Agency for the cyanide-containing wastes has been tabulated. To determine BDAT, the EPA examined all available performance data for the demonstrated technologies to determine whether one of these technologies performs significantly better than the others. The technology that performs best on a particular waste or waste subcategory was then evaluated to determine whether it is commercially available and provides 'substantial' treatment. Constituents selected for regulation must satisfy the following criteria: (1) they must be on or indicators of constituents on the BDAT list of regulated constituents; (2) they must be present in, or suspected of being present in, the untreated waste; and (3) the selected constituents must be easier to treat than any waste constituent from which performance data are transferred. Air oxidation was found to have the best treatment performance for electroplating operations cyanide wastes; list metals may require treatment by chemical precipitation followed by filtration and sludge dewatering. Electrolytic oxidation followed by alkaline chlorination provides appropriate measures for metal heat treating cyanide wastes; list metals wastes from this process are best treated by stabilization. Other miscellaneous wastes of concern can best be treated by ultraviolet-light enhanced ozonation, wet air oxidation, or incineration. (Fish-PTT)
W91-03219

SECONDARY ECONOMIC IMPACT OF ACID DEPOSITION CONTROL LEGISLATION IN SIX COAL PRODUCING STATES.
Battelle Pacific Northwest Labs., Richland, WA.
M. J. Scott, and S. J. Guthrie.
Available from the National Technical Information Service, Springfield, Virginia 22161, as DE89-005487. Price codes: A04 in paper copy, A01 in microfiche. Report no. PNL-6669/UC-11, December 1988. 66 p, 1 fig, 17 tab, 15 ref, append. Contract no. DE-AC06-76RL0 1830.

Descriptors: *Acid rain effects, *Air pollution control, *Coal mining, *Economic impact, *Emission control, *Water pollution prevention, Coal wastes, Employment, Illinois, Indiana, Kentucky, Legislation, Ohio, Pennsylvania, Powerplants, Sulfur, West Virginia.

Significant policy concern has been expressed concerning the dollar costs to the nation's economy of achieving the intended effects of acid rain control legislation and the potential impacts on economic activity--in particular, losses of both coal mining and secondary service sector employment in states and regions dependent on the mining of high sulfur coal. The states selected for the analysis are those in which losses in high sulfur coal production are expected as a result of many acid rain control proposals. The selected scope of the study highlights the most obvious negative employment effects of such a program. The two pieces of legislation considered are the Proxmire and Mitchell Bills, which call for reduced sulfur emissions from power plants, have been predicted to cause switch-

ing from high to low sulfur coal, and may also force utilities to install more effective scrubbers. The most obvious of the negative local economic effects of acid deposition control is expected to be the effects of coal switching on six traditional coal producing states in the Appalachian and Midwestern coal producing regions: Illinois, Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia. Under either bill the overall economic impacts are significant, particularly in three states: Illinois, Ohio, and Pennsylvania. The absolute impacts represent less than one percent of the 1986 level of economic activity in the states in which they occur. Sensitivity cases confirmed the importance of scrubber technology in reducing the economic effects of changing coal production. (Fish-PTT)
W91-03220

DEVELOPING A STATE WELLHEAD PROTECTION PROGRAM: A USER'S GUIDE TO ASSIST STATE AGENCIES UNDER THE SAFE DRINKING WATER ACT.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
For primary bibliographic entry see Field 5F.
W91-03222

ANALYSIS OF PERFORMANCE LIMITING FACTORS (PLFS) AT SMALL SEWAGE TREATMENT PLANTS.
Environmental Protection Agency, Washington, DC. Office of Municipal Pollution Control.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-193346. Price codes: A03 in paper copy, A01 in microfiche. Report no. OMPC-10-89, April 1989. 20 p, 3 tab.

Descriptors: *Clean Water Act, *Performance evaluation, *Wastewater facilities, *Wastewater management, *Wastewater treatment, Administrative decisions, Cost analysis, Operating policies, Systems engineering.

The Environmental Protection Agency has long been gathering data on the successes and problems of federally funded wastewater treatment systems. Since 1982, the On-Site Operator Assistance Program, created under Section 104(g) (1) of the Clean Water Act, has been sending technical experts to small POTWs to help operators and managers solve debilitating problems. Since the program's beginning, the '104' troubleshooters have compiled operation and maintenance evaluations (OMEs) for the plants they have visited. This wealth of technical information has recently been analyzed to discover what generalized practical advice can be offered about solving operational problems at small POTWs. Analysts examined 150 POTWs selected to be representative of all plants in the database, not just nationally, but within EPA Regions. Some conclusions and recommendations made are: activated sludge may not be a good design choice for many small plants; fixed media or lagoons may be better options. Plant inflexibility undermines operability. Small plants have front-end and back-end problems with process design; grit removal and sludge dewatering and disposal options should be considered. Design engineers and community administrators should agree on realistic loading levels for the facility. Staffing difficulties aggravate poor performance; plant administrators should increase operator status and visibility, seek to attract better staff, and strive to keep good staff. Plant budgets and user charges may be too low. Municipal support is a subtle but vital need. (Fish-PTT)
W91-03223

NNEPS (NATIONAL NETWORK FOR ENVIRONMENTAL POLICY STUDIES) FINAL REPORT: EPA (ENVIRONMENTAL PROTECTION AGENCY) REGION 1 WELLHEAD PROTECTION EFFORTS.
Yale Univ., New Haven, CT. School of Forestry and Environmental Studies.
P. L. Stern.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-203764. Price codes: A03 in paper copy, A01 in microfiche. Report no. 600/9-89/050, August 1988. 19 p, append. Contract no. U-913-992-01-0.

Descriptors: *Environmental policy, *Geographic information systems, *Government supports, *Groundwater management, *Water pollution prevention, *Water resources management, Computer programs, Groundwater pollution, Groundwater recharge, Risk assessment, Water pollution sources, Water quality management.

Three wellhead protection projects were undertaken in EPA's Region One: the Cape Cod Aquifer Management Plan (CCAMP); Region One's Priority Ground Water Resource-Based Mapping Project: the Nashua Regional Planning Commission Pilot Area; and the Chesprocott Groundwater Protection Project. All three projects are aimed at preventing contamination of community wells. CCAMP serves as a prototype for Region One's wellhead protection efforts and may be broken down into four main phases: delineating the critical groundwater recharge area of each community well, identifying and assessing the risk of existing and future sources of contaminants within the Wellhead Protection Area (WHPA), examining the adequacy of existing management strategies to prevent groundwater contamination, and implementing local management controls based on the results of the first steps. The other two wellhead protection projects were based on CCAMP, and essentially follow the same steps. All three projects use Geographic Information System (GIS) technology. The location and essential information on wells and sources of contamination are first checked in the field, and then digitized into the GIS computer system. The result is a state-of-the-art management tool which will be of tremendous value to all agencies involved in groundwater management. All three projects develop and refine management ideas and methodologies on the prevention of groundwater contamination, which may be used by local and regional agencies concerned with protecting their groundwater resources. (Fish-PTT)
W91-03227

AEROBIC DENITRIFICATION AS AN INNOVATIVE METHOD FOR IN SITU BIOLOGICAL REMEDIATION OF CONTAMINATED SUBSURFACE SITES.
Air Force Engineering and Services Center, Tyndall AFB, FL. Engineering and Services Lab.
L. N. Britton.
Available from the National Technical Information Service, Springfield, Virginia 22161, as AD-A208 812. Price codes: A05 in paper copy, A01 in microfiche. Report no. ESL-TR-88-40, January 1989. 82 p, 16 fig, 10 tab, 74 ref, append. Contract no. FO 8635-86-C-0158.

Descriptors: *Aerobic treatment, *Bioremediation, *Denitrification, *In situ treatment, *Site remediation, *Water pollution treatment, Biodegradation, Enrichment, Nitrates, Nutrients, Organic compounds, Oxygen demand, Phenols, Subsurface water.

Laboratory testing was conducted of an aerobic denitrification concept for the enhancement of in situ bioremediation of subsurface sites. Microbial enrichments using phenol, dodecane, toluene, naphthalene, and methylene chloride demonstrated that many soil organisms classically associated with degradation of these organics are also capable of respiring with nitrate. Chemostat experiments with an isolate from the enrichments were performed to follow phenol degradation at varying oxygen concentrations. Nitrate respiration and aerobic phenol degradation could occur simultaneously at oxygen concentrations as high as 10% in the sparging gas. Thus the concept of aerobic denitrification was proven. An enhancement of biodegradation of phenol occurred when the isolate was provided nitrate, in lieu of oxygen, as a final electron acceptor for respiration. This enhancement was attributed to the decreased oxygen demand for phenol oxidation. Tentative evidence using a mixed culture demonstrated that nitrate could increase mineralization of certain organics in limiting oxygen. The study provided proof of concept that the addition of nitrate could enhance in situ biodegradation of organic contaminants in subsurface sites by decreasing the oxygen demand. (Fish-PTT)
W91-03229

DRINKING WATER HEALTH DOCUMENT ON STYRENE.
Environmental Protection Agency, Cincinnati, OH. Office of Drinking Water.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-192272. Price codes: A12 in paper copy, A01 in microfiche. Final Report no. ECAO-CIN-409, January 1988. 262 p, 1 fig, 20 tab, 294 ref.

Descriptors: *Administrative regulations, *Drinking water, *Safe Drinking Water Act, *Styrene, *Water quality standards, *Water treatment, Carcinogens, Performance evaluation, Population exposure, Public health, Toxicology, Water pollution control.

The Safe Drinking Water Act, as amended in 1986, requires the Administrator of the Environmental Protection Agency (EPA) to publish maximum contaminant level goals (MCLGs) and promulgate National Primary Drinking Water Regulations for each contaminant, which, in the judgment of the Administrator, may have an adverse effect on public health and which is known or anticipated to occur in public water systems. The Office of Drinking Water of the EPA has prepared a Drinking Water Criteria Document on Styrene. This Criteria Document is an extensive review of the following topics: physical chemical properties of styrene, toxicokinetics and human exposure to styrene, health effects of styrene in humans and animals, mechanisms of toxicological effect of styrene, and quantification of toxicological effects of styrene. Styrene is a clear, colorless liquid with a characteristic odor, molecular weight of 104.16, vapor pressure of 4.3 torr, and a water solubility of 320 mg/L. Animal studies indicate that distribution of absorbed styrene is widespread and rapid, but is fairly readily eliminated. Exposure estimates for styrene in drinking water (low-high) are 0-0.25 microg/L, in food 100 microg/kg, and in air 0-6,500 microg/cu m. The major source of exposure is from ambient and indoor air. When the animal bioassay data and the metabolic/genotoxicity data are considered, there is a reasonable basis for classifying styrene as having a 'sufficient' level of carcinogenic evidence in animal test systems, but there are inadequate data to indicate that styrene is a human carcinogen. (Fish-PTT)
W91-03230

REGULATORY IMPACT ANALYSIS: BENEFITS AND COSTS OF FINAL SURFACE WATER TREATMENT RULE.
Miller (Wade) Associates, Inc., Arlington, VA.
For primary bibliographic entry see Field 5F.
W91-03235

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR ORGANOPHOSPHORUS WASTES.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
R. April, and M. Cunningham.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-221444. Price codes: A04 in paper copy, A01 in microfiche. Report no. EPA/530-SW-89-048G, June 1989. 4 fig, 10 tab, 10 ref. Contract no. 68-01-7053.

Descriptors: *Administrative regulations, *Organophosphorus compounds, *Waste management, *Waste treatment, *Wastewater treatment, *Water quality standards, Carbon filters, Incineration, Land disposal, Performance evaluation, Pesticides, Waste characteristics, Wastewater management.

The Environmental Protection Agency (EPA) is establishing treatment standards based on the best demonstrated available technology (BDAT) for organophosphorus wastes. These wastes are specif-

ically generated in the production of phorates and disulfoton (organic pesticide products). Since the organophosphorus wastes contain organics, the technologies applicable to the untreated listed wastes should include those that destroy or reduce the total amount of various organic compounds in the waste. For wastewaters and nonwastewaters, the EPA has identified incineration as an applicable and demonstrated technology to treat the organophosphorus wastes. However, it seemed impractical to require all wastewater streams to be incinerated; thus, the EPA is promulgating 'Incineration or Carbon Adsorption as a Method of Treatment.' The residual from nondestructive treatment, i.e., the spent carbon, is still considered to be the same waste code as before treatment, and must be managed as such. It therefore must be incinerated prior to land disposal. (Fish-PTT)
W91-03236

40 CFR 265 INTERIM-STATUS GROUND-WATER MONITORING PLAN FOR THE 2101-M POND.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5A.
W91-03238

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR K043.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
R. April, and J. Vorbach.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-221493. Price codes: A03 in paper copy, A01 in microfiche. Report no. EPA/530-SW-89-048L, June 1989. 45 p, 12 tab, 13 ref, 2 append.

Descriptors: *Administrative regulations, *Pesticides, *Waste disposal, *Waste management, *Wastewater treatment, *Water pollution prevention, *Water quality standards, Chlorinated hydrocarbons, Incineration, Land disposal, Waste characteristics, Wastewater management.

In accordance with the Resource Conservation and Recovery Act (RCRA), the Environmental Protection Agency (EPA) is establishing best demonstrated available technology (BDAT) treatment standards for K043 waste (2,6-dichlorophenol waste from the production of 2,4-dichlorophenoxyacetic acid by the pesticides industry). Compliance with the BDAT treatment standards is a prerequisite for the placement of the waste in facilities designated as land disposal units. K043 waste contains primarily chlorinated organic compounds, less than 2 percent ash, and no water. The EPA has identified fuel substitution and incineration as applicable technologies for treating the organic constituents in untreated K043 waste. Because K043 waste contains only trace amounts of BDAT list metals, residuals are not expected to contain treatable levels of these metals; therefore, no applicable technologies have been identified. Incineration is the only 'demonstrated,' 'best,' and 'available' technology for K043 waste, and is therefore BDAT. The EPA is regulating 13 of the 21 candidates either detected or believed to be present in K043 waste, including the seven volatile and semivolatile candidates, but is not regulating any metal constituents. Treatment standards for regulated semivolatile constituents range from 0.34 (2,6-dichlorophenol) to 7.6 mg/L (2,4,6-trichlorophenol) for nonwastewater, and 0.013 to 0.039 mg/L for the same wastewater constituents. The only volatile constituent is tetrachloroethene with a treatment standard of 1.7 mg/L for nonwastewater, and 0.006 mg/L as a wastewater constituent. (Fish-PTT)
W91-03241

RCRA GROUND-WATER MONITORING PROJECTS FOR HANFORD FACILITIES: ANNUAL PROGRESS REPORT FOR 1988.
Battelle Pacific Northwest Labs., Richland, WA.
R. M. Fruland, and R. E. Lundgren.
Available from the National Technical Information Service, Springfield, Virginia 22161, as DE89-011028. Price codes: A05 in paper copy, A01 in microfiche. Report no. PNL--6852, April 1989. 87 p, 23 fig, 8 tab, 21 ref. Contract no. DE-AC06-76RLO 1830.

Descriptors: *Groundwater pollution, *Hazardous wastes, *Monitoring, *Path of pollutants, *Radioactive waste disposal, *Resource Conservation and Recovery Act, *Washington, *Waste disposal, *Water quality, Administrative regulations, Drinking water, Groundwater level, Hazard assessment, Water pollution sources, Water quality standards.

Fourteen Hanford Site groundwater monitoring projects in Washington State, covering 16 hazardous waste facilities and one nonhazardous waste facility, are being conducted according to federal regulations based on the Resource Conservation and Recovery Act (RCRA) of 1976 and the State of Washington Administrative Code. All of the groundwater monitoring projects are under interim-status regulations, and most are in their first year of background groundwater monitoring. Only two are groundwater quality assessment monitoring projects. The status of the project and the work conducted during calendar year 1988 have been summarized. The water-level elevations for 1988, and the indicator parameters for the one project that has reached this phase have been compiled. For groundwater quality assessment projects, water-table evaluations are followed by a summary of 1988 analytical results for constituents above drinking water standards. There are two constituents recorded by several projects that are currently suspected of not representing true groundwater conditions: methylene chloride (dichloromethane) and chromium. The occurrence of these constituents are being carefully monitored and evaluated to determine their true sources. (Fish-PTT)
W91-03242

WETLAND CREATION AND RESTORATION: THE STATUS OF THE SCIENCE.
For primary bibliographic entry see Field 2L.
W91-03244

WETLAND MITIGATION ALONG THE PACIFIC COAST OF THE UNITED STATES.
San Francisco State Univ., Tiburon, CA. Tiburon Center for Environmental Studies.
For primary bibliographic entry see Field 2L.
W91-03245

CREATION AND RESTORATION OF TIDAL WETLANDS OF THE SOUTHEASTERN UNITED STATES.
North Carolina State Univ., Raleigh. Dept. of Soil Science.
For primary bibliographic entry see Field 2L.
W91-03246

CREATION AND RESTORATION OF COASTAL PLAIN WETLANDS IN FLORIDA.
Lewis Environmental Service, Inc., Tampa, FL.
For primary bibliographic entry see Field 2L.
W91-03247

CREATION AND RESTORATION OF COASTAL WETLANDS IN PUERTO RICO AND THE U.S. VIRGIN ISLANDS.
Lewis Environmental Service, Inc., Tampa, FL.
For primary bibliographic entry see Field 2L.
W91-03248

CREATION AND RESTORATION OF COASTAL WETLANDS OF THE NORTHEASTERN UNITED STATES.
For primary bibliographic entry see Field 2L.
W91-03250

REGIONAL ANALYSIS OF THE CREATION AND RESTORATION OF SEAGRASS SYSTEMS.
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
For primary bibliographic entry see Field 2L.
W91-03251

CREATION AND RESTORATION OF FORESTED WETLAND VEGETATION IN THE SOUTHEASTERN UNITED STATES.
For primary bibliographic entry see Field 2H.
W91-03252

FRESHWATER MARSH CREATION AND RESTORATION IN THE SOUTHEAST.
Erwin (Kevin L.) Consulting Ecologist, Inc., Fort Myers, FL.
For primary bibliographic entry see Field 2H.
W91-03253

RESTORATION AND CREATION OF PALUSTRINE WETLANDS ASSOCIATED WITH RIVERINE SYSTEMS OF THE GLACIATED NORTHEAST.
For primary bibliographic entry see Field 2H.
W91-03254

REGIONAL ANALYSIS OF THE CREATION AND RESTORATION OF KETTLE AND POTHOLE WETLANDS.
For primary bibliographic entry see Field 2H.
W91-03255

REGIONAL ANALYSIS OF FRINGE WETLANDS IN THE MIDWEST: CREATION AND RESTORATION.
Indiana Univ. at Bloomington. School of Public and Environmental Affairs.
For primary bibliographic entry see Field 2H.
W91-03256

CREATION AND RESTORATION OF RIPARIAN WETLANDS IN THE AGRICULTURAL MIDWEST.
Indiana Univ. at Bloomington. School of Public and Environmental Affairs.
For primary bibliographic entry see Field 2H.
W91-03257

CREATION AND RESTORATION OF RIPARIAN HABITAT IN SOUTHWESTERN ARID AND SEMI-ARID REGIONS.
SWCA, Inc., Tucson, AZ.
For primary bibliographic entry see Field 2H.
W91-03258

RESTORATION OF DEGRADED RIVERINE/RIPARIAN HABITAT IN THE GREAT BASIN AND SNAKE RIVER REGIONS.
White Horse Associates, Smithfield, UT.
For primary bibliographic entry see Field 2E.
W91-03259

WETLANDS RESTORATION/CREATION/ENHANCEMENT TERMINOLOGY: SUGGESTIONS FOR STANDARDIZATION.
Lewis Environmental Service, Inc., Tampa, FL.
For primary bibliographic entry see Field 2H.
W91-03261

RESTORATION OF THE PULSE CONTROL FUNCTION OF WETLANDS AND ITS RELATIONSHIP TO WATER QUALITY OBJECTIVES.
Butler Univ., Indianapolis, IN. Holcomb Research Inst.
For primary bibliographic entry see Field 2H.
W91-03265

WETLAND AND WATERBODY RESTORATION AND CREATION ASSOCIATED WITH MINING.
Pennsylvania State Univ., University Park. Forest Resources Lab.
For primary bibliographic entry see Field 4C.
W91-03270

WASTE MANAGEMENT SCHEMES OF POTASH MINES IN SASKATCHEWAN.
Manitoba Hydro, Winnipeg.
J. E. Tallin, D. E. Pufahl, and S. L. Barbour.
Canadian Journal of Civil Engineering CJCEB8, Vol. 17, No. 4, p 528-542, August 1990. 14 fig, 25 ref.

Descriptors: *Brine disposal, *Canada, *Mine wastes, *Waste management, *Water pollution prevention, Case studies, Dykes, Groundwater pollution, Linings, Potash, Wastewater disposal, Wastewater treatment.

Saskatchewan's potash industry, when operating at capacity, produces 28 million tons of salt tailings and 11 million cu m of concentrated brine per year. The seepage of brine into the surrounding soil and groundwater presents a challenge to waste management. Diversion ditches are used to collect contaminated seepage. Where there is danger of contaminating an underlying aquifer, liners may be beneficial. Cutoff walls consist of a trench excavated through a permeable strata and backfilled with a low-permeability material to prevent lateral spreading of contaminants through the strata. The slurry trench method uses a low-permeability soil-water slurry to keep the trench open during the excavating and backfilling operations. Interceptor ditches intercept groundwater flow occurring in shallow permeable deposits, however, regular maintenance is needed to ensure their proper drainage in loose deposits containing silt and fine sand. Buried drains consist of a perforated pipe at the bottom of a trench backfilled with sand or gravel to act as a filter between the natural soil and the pipe. The Potash Corporation of Saskatchewan Mining Limited (PCS), Cory Division maintains tailings and slime settling ponds with dykes and a slurry trench cutoff wall. The Potash Company of America Limited has a waste containment area consisting of a system of ponds including Patience Lake. A dyke was constructed across the north end of the lake to prevent migration of the brines to streambeds. The PCS, Lanigan Division has a waste disposal basin with an inner and an outer pond. Dykes surrounding both the inner and outer ponds were designed with cutoffs. A seepage interceptor drain was recently installed to intercept seepage occurring through or beneath the cutoff. A diversion ditch was upgraded to divert runoff water from the site and prevent it from entering the ponds. The PCS, Rocanville Division has ponds lined with a polyethylene membrane because the surficial deposits are very permeable. Newer ponds are lined with a high-density polyethylene. Brine losses from the original ponds are intercepted by collector ditches. Additional pump wells were installed to inhibit the advancement of the brine plume in the inter-till aquifer. (Geiger-PTT)
W91-03304

APPROPRIATE METHODOLOGIES FOR DEVELOPMENT AND MANAGEMENT OF GROUNDWATER RESOURCES IN DEVELOPING COUNTRIES.
For primary bibliographic entry see Field 2F.
W91-03311

IMPACT OF INTENSIVE IRRIGATION ON GROUNDWATER REGIMEN IN PARTS OF OSMANSAGAR AREA, R. R. DISTRICT, A. P., INDIA.
Osmania Univ., Hyderabad (India). Dept. of Geology.
G. Shankar Narayana, D. Vidyanath, and J. V. S. Murty.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 709-714, 1 tab, 5 ref, map.

Descriptors: *Geohydrology, *Groundwater pollution, *India, *Irrigation effects, *Nonpoint pollution sources, *Water pollution sources, Aquifers, Conductivity, Groundwater chemistry, Groundwater management, Sulfates, Vine crops.

The groundwater regime around the Twin Cities (India) has deteriorated greatly since the 1960s, when water was uniformly palatable for drinking. Effects have been greatest in extensively irrigated tracts. Specific electrical conductance of the groundwater in extensively irrigated areas ranges from 2850-5000 mmhos/cm at 25 C. The concentration of sulfates also is very high. Physiography, hydrogeology, and water chemistry of this area were studied as part of an assessment of the effects of irrigation on local groundwater. High electrical conductivity values were recorded for the groundwaters of vineyards; the older the vineyard, the higher the electrical conductivity value. Use of groundwater from intensively irrigated areas in low-potential aquifers of the peninsular basement gneissic complex should be stopped. If not, the soil of these areas will deteriorate, turning vast irrigated tracts into wastelands. (See also W91-03311) (Rochester-PTT)
W91-03334

SAFEGUARDS FOR GROUNDWATER POLLUTION IN INDIA.
Malvia Regional Engineering Coll., Jaipur (India).
R. D. Verma.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 841-851, 24 ref.

Descriptors: *Groundwater management, *Groundwater pollution, *India, *Urbanization, *Water pollution prevention, Agricultural runoff, Comparison studies, Fertilizers, Groundwater reservoirs, Organic solvents, Pesticides, Solid wastes, United States, Wastewater disposal, Wastewater pollution.

Groundwater pollution has become a major issue in the development of natural resources and the protection of the environment. Many cases of groundwater pollution in India have been reported. A review of these reports identifies the following causes: haphazard urban development without adequate attention to sewage and waste disposal, rapid industrialization without proper treatment and disposal of waste products, unsanitary dumping of refuse and other solid wastes near aquifers, excessive use of fertilizers and pesticides for agricultural development and poor drainage in agricultural soils. The use of groundwater reservoirs for waste storage and artificial recharge, if not properly planned and designed, would seriously impair groundwater quality. The presence of organic chemicals, especially solvents, in groundwater supplies has been reported from the United States and other industrialized countries. The hazardous wastes generated every year in the developed countries, when not properly disposed of, have caused severe groundwater pollution. Examining the experiences in developed countries with respect to future industrial development and water usage in India shows that, if adequate long-term safeguards are not imposed to prevent groundwater pollution, the quality of the groundwater could become a limiting factor for the use of this resource. (See also W91-03311) (Author's abstract)
W91-03346

HYDROCHEMICAL CLASSIFICATION OF THE GROUNDWATER OF THE WADI AL BIH WELLFIELD IN THE NORTHERN PART OF THE UNITED ARAB EMIRATES.
United Arab Emirates Univ., Al Ain. Dept. of Geology
For primary bibliographic entry see Field 2K.
W91-03347

NITRATE POLLUTION OF GROUNDWATER IN LUCKNOW AREA, U. P.
Central Ground Water Board, Lucknow (India).
For primary bibliographic entry see Field 5B.
W91-03349

SCIENTIFIC BACKGROUND FOR THE DEVELOPMENT OF REGULATIONS FOR RADIONUCLIDES IN DRINKING WATER.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
P. Milvy, and R. Cothern.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 1-16. 3 fig, 10 tab, 20 ref.

Descriptors: *Drinking water, *Legal aspects, *Legislation, *Radioisotopes, *Regulations, *Water quality standards, *Water treatment, Economic aspects, Public health, Radioactivity effects, Radon, Risk assessment, Uranium.

The occurrence, exposure, and risks posed by naturally occurring radionuclides in public drinking water supplies were examined. In the context of these data and considering the feasibility and cost of compliance, several regulatory approaches that could be implemented to protect public health were considered. The hypothetical, but realistic maximum contaminant levels for radon and uranium and the effect of these standards on reducing the health risks of drinking water caused by these two radionuclides were also examined. It is suggested that the flexibility of the Safe Drinking Water Act allows setting of the maximum contaminant levels for the regulation of radon's and uranium's alpha particle effects at levels that are not totally independent of each other, but that are interrelated such that maximum health benefits are achieved. To achieve this requires a policy that emphasizes a relatively stringent radon standard. It can be achieved by relaxing the uranium standard at little sacrifice to health, but with a large saving of resources. To justify this, these resources must then be used to reduce the considerably greater risk posed by radon. A net reduction in risk is achieved at no increased resource expenditure. It is noted that neither the uranium nor the radon maximum contaminant level is set at a level that significantly exceeds the level of risk considered by the U.S. Environmental Protection Agency as being protective of public health. (See also W91-03366) (Author's abstract)
W91-03367

TREATMENT TECHNOLOGY FOR REMOVING RADON FROM DRINKING WATER SUPPLIES.
New Hampshire Univ., Durham. Environmental Research Group.
For primary bibliographic entry see Field 5F.
W91-03370

REMOVAL OF URANIUM FROM DRINKING WATER BY CONVENTIONAL TREATMENT METHODS.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
For primary bibliographic entry see Field 5F.
W91-03377

PRICE OF CONFIDENCE: THE RATIONALITY OF RADIUM REMOVAL FROM DRINKING WATER.
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 5F.
W91-03380

CONTRACTORS, INJECTION WELLS, AND THE TC RULE.
National Water Well Association, Worthington, OH.
C. Reimer.
Water Well Journal WWJOA9, Vol. 44, No. 11, p 61-62, November 1990. 1 tab.

Descriptors: *Hazardous wastes, *Injection wells, *Regulations, *Toxicity, *Underground waste disposal, *Waste disposal, *Water pollution sources, Chemical wastewater, Disposal wells, Environmental protection, Industrial wastes, Sewers, Storage tanks.

With the Resource Conservation and Recovery Act (RCRA), there are two mechanisms for determining if wastes are hazardous. One mechanism is for EPA to identify and list particular wastes. The second mechanism is a determination by the waste generator based on knowledge or testing that the waste is 'characteristically' hazardous. Wastes are characteristically hazardous due to ignitability, reactivity, corrosivity, or toxicity characteristic (TC rule). The TC rule replaces the extraction procedure. It expands the number of wastes that will be considered hazardous because of its new procedures and because it adds 25 organic constituents to the list that must be considered. Because of the TC regulation, some formerly nonhazardous injection fluids will now be considered hazardous waste. Some Class V (shallow injection wells that dispose of hazardous or radioactive wastes into or above an underground source of drinking water) wells will be reclassified as prohibited Class IV because they inhibit a newly defined 'characteristic' hazardous waste at a concentration greater than the regulatory level into or above an underground source of drinking water. Operations that EPA has identified as potentially having Class IV wells include industrial facilities in areas that are not sewered or in which a request to discharge into the sanitary sewer has been denied. Industry types most likely to generate characteristically hazardous waste are those which many facture petroleum products, textiles, industrial organic chemicals, plastic materials and synthetic resins, synthetic rubber, cellulosic and other man-made fibers, electronic manufacturers, and small plating and other metal fabricating operations. Automobile service stations, repair shops, and car washing activities in unsewered areas or municipalities with restrictions on sewer hookups for industries may also have class IV wells, as may large tank farms and chemical storage facilities. (Lantz-PTT)
W91-03391

WATER QUALITY CHANGES ASSOCIATED WITH ROTARY DITCHED AND BREACHED MOSQUITO CONTROL IMPOUNDMENTS IN MOSQUITO LAGOON.
East Volusia Mosquito Control District, Daytona Beach, FL.
For primary bibliographic entry see Field 2L.
W91-03439

PRECIPITATION CHEMISTRY: ATMOSPHERIC LOADINGS TO THE SURFACE WATERS OF THE INDIAN RIVER LAGOON BASIN BY RAINFALL.
Bionetics Corp., Cocoa Beach, FL.
For primary bibliographic entry see Field 2K.
W91-03440

COMPLEMENTARY INVESTIGATIVE TECHNIQUES FOR SITE ASSESSMENT WITH LOW-LEVEL CONTAMINANTS.
Science Applications International Corp., Golden, CO. Environmental Remediation Div.
M. E. Byrnes, R. W. Nelson, R. G. La Poe, D. E. Lundquist, and W. McNeill.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 4, p 90-95, Fall 1990. 4 fig, 4 ref.

Descriptors: *Groundwater pollution, *On-site investigations, *Organic chemicals, *Site remediation, *Water pollution sources, *Water pollution treatment, Aerial photography, California, Chemical analysis, Chlorinated hydrocarbons, Groundwater movement, Hazardous wastes, Landfills, Mass spectrometry, Permeability, Physical analysis, Vandenberg Air Force Base, Water quality monitoring.

A remedial investigation was performed in an area downgradient from an abandoned missile silo at Vandenberg Air Force Base, California, as part of the United States Air Force Installation Restoration Program. A number of complementary investigative techniques were used to assure a reliable assessment of site contamination. These included the review of aerial photographs, the use of an organic vapor analyzer, and a carbon adsorption/mass spectrometer method to conduct a soil-gas survey; magnetic and electromagnetic geophysical surveys; bedrock permeability testing; and the chemical analysis of soil, sediment, surface water and groundwater samples. The results from this investigation revealed the presence of an undocumented landfill and a small trichloroethylene plume in groundwater at concentrations ranging from 6.7 to 31 ppb. The investigation also identified local groundwater flow direction, provided strong evidence of the location of potential sources of contamination, and defined the downgradient extent of groundwater contamination. Because the identified contaminants have not yet reached the environmentally sensitive wetland at the base of the slope below this facility, there is still time to propose remedial alternatives that would protect this area. (Author's abstract)
W91-03445

GROUND WATER MONITORING AT WELLHEAD PROTECTION AREAS.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
P. D. Meyer.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 4, p 102-109, Fall 1990. 6 fig, 20 ref.

Descriptors: *Groundwater quality, *Monitoring, *Network design, *Water quality control, *Water quality monitoring, *Wellhead protection, *Wells, Geohydrology, Nonpoint pollution sources, Water pollution sources, Water quality management.

Wellhead protection (WHP) programs have no included a comprehensive groundwater monitoring strategy. The elements of wellhead protection program important from a monitoring perspective are the management objectives, the types of potential contaminant sources, and the locations of those sources with respect to the wellhead protection area (WHPA) boundary. Hydrogeologic monitoring provides the basic information on which WHPA delineation is based. A comprehensive groundwater monitoring program for WHP program assessment includes five strategies: (1) monitoring at the water supply well(s); (2) monitoring at the boundaries of the WHPA zone(s); (3) monitoring of a particular point source; (4) monitoring of a non-point source; and (5) monitoring without regard to any boundaries or specific sources. (MacKeen-PTT)
W91-03447

METHODS DEVELOPMENT AND IMPLEMENTATION FOR THE NATIONAL PESTICIDE SURVEY.
Environmental Protection Agency, Cincinnati, OH.
For primary bibliographic entry see Field 5A.
W91-03507

TOXICOLOGY AND DRINKING WATER REGULATIONS.
R. W. Pontius.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 10, p 14-17, 90, October 1990. 2 tab.

Descriptors: *Drinking water, *Safe Drinking Water Act, *Toxicology, *Water quality standards, *Water treatment, Carcinogens, Environmental Protection Agency, Epidemiology, Specifications, Water policy, Water pollution.

The US Safe Drinking Water Act requires the US EPA to regulate drinking water contaminants to protect public health. For each contaminant specified in the Safe Drinking Water Act or those that may have any adverse effect on health the US EPA must establish a nonenforceable maximum contaminant level goal and an enforceable maximum contaminant level or treatment technique. A maximum contaminant level goal is established for a contaminant based on toxicology data on the contaminant's potential health effects associated with drinking water. Data evaluated include human epidemiology or clinical studies and animal-exposure studies. Language specifying how known or probable human carcinogens (Category I) are to be regulated is not contained in the Safe Drinking Water Act, but congressional guidance was provided in House Report 93-1185. US EPA must consider the possible impact of synergistic effects, long-term and multistage exposures and the existence of more susceptible groups in the population. For noncarcinogenic (category III) contaminants, US EPA determines a no effect level (known as the reference dose) for chronic or lifetime periods of exposure. Category II contaminants are not regulated as human carcinogens; however, they are treated more conservatively than category III contaminants. The Safe Drinking Water Act requires the US EPA to set either a maximum contaminant level or a treatment technique for each contaminant that has a maximum contaminant level goal. Maximum contaminant levels must be set as close to their respective maximum contaminant level goals as feasible with the use of best available technology, taking costs into consideration. (Mertz-PTT)
W91-03526

ELECTROCHEMICAL PROCESSING OF SOILS: THEORY OF PH GRADIENT DEVELOPMENT BY DIFFUSION, MIGRATION, AND LINEAR CONVECTION.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
Y. B. Acar, R. J. Gale, G. A. Putnam, J. Hamed, and R. L. Wong.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 6, p 687-714, August 1990. 9 fig, 39 ref.

Descriptors: *Cleanup, *Decontamination, *Electro-osmosis, *Electrochemistry, *Model studies, *Soil chemistry, *Soil contamination, *Soil treatment, *Water pollution treatment, Flow pattern, Hydrogen ion concentration, Interstitial water, Mathematical equations, Physicochemical treatment, Soil processing, Theoretical analysis.

A theory, based on the Nernst-Planck equations, is presented for pH gradient development during the electrochemical processing of soils. The theory can be applied to techniques using electrochemical processing for the decontamination of polluted media. Formation of an acidic front at the anode from water electrolysis and the induced electro-osmotic flow of pore fluid contribute to facilitate removal of contaminants. The model provides a first-order, mathematical framework to examine the flow patterns and chemistry generated in electro-osmosis. Analytical solutions were compared with the numerical results obtained by the finite element method (FEM) with some preliminary experimental results. The FEM results were in good agreement with the analytical solutions of the model for diffusion only conditions. For the case of one-dimensional ion flow by diffusion and convection, agreement is good at earlier stages of the process, when the boundary conditions at the outlet are not felt. Upstream-downstream effects are included in the model, but consolidation effects, neutralization, and ion exchange reactions need to be quantified and incorporated into the model. The physical basis of electro-osmosis phenomena needs to be better established. Modeling approaches of this type should assist scale-up of this technology for common inorganic toxic pollutants. (Author's abstract)
W91-03539

POND SEEPAGE IN TWO AND THREE DIMENSIONS.
Texas A and M Univ., College Station. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2E.
W91-03545

SUPERFUND RECORD OF DECISION: MONTGOMERY TOWNSHIP HOUSING DEVELOPMENT, NJ.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-204770/AS. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/ROD/R02-88/060. June 1988. 63p, 8 fig, 6 tab.

Descriptors: *Cleanup operations, *New Jersey, *Path of pollutants, *Superfund, *Trichloroethylene, Air stripping, Costs, Water supply, Wells.

The Montgomery Township Housing Development (MTHD) site is located in Somerset County, New Jersey. The Rocky Hill Municipal Wellfield (RHMW) Superfund site is also covered by this remedial action because of its proximity to the MTHD and the similarity of the contaminants present. The 72-acre MTHD site is a development which includes 71 private homes, with an additional 6 homes affected by the contamination in the surrounding residential areas. The RHMW consists of a two-acre tract of land in the Borough of Rocky Hill, which supplies public water to the residents of Rocky Hill. In 1978, a study of the RHMW revealed trichloroethylene (TCE) contamination, which led to closure of one well and eventual installation of an air stripping treatment unit on the well in 1983. Concern over the groundwater contamination in Rocky Hill spurred the initial sampling of residential wells in MTHD from December 1979 to January 1980. In March 1981, Elizabethtown Water Company water lines were installed in MTHD, and residents were advised not to use well water. Twenty homes initially elected to connect to the municipal supply, and at the present time 38 residences have hooked up. In September 1987, an operable unit Record of Decision (ROD) was signed by EPA, which provides for the supply of alternate water through the permanent hookup of all MTHD residences, and six residences outside of MTHD, to the available public water supply system. Incomplete field investigations have identified 13 possible sources of contamination. The nearby Princeton Gamma Tech property has been identified as a primary source of TCE contamination in the area. The primary contaminant of concern affecting the groundwater is TCE. The selected remedial action for this site includes: groundwater pump and treatment using air stripping and reinjection of the treated water back into the aquifer; connecting any remaining affected residences to the public water supply and sealing of remaining private water supply and monitoring wells within the contaminant plume; and implementation of groundwater monitoring. Present worth cost for this remedial action is $2,548,000 with annual O&M costs of $94,000. (Author's abstract)
W91-03561

SUPERFUND RECORD OF DECISION: EWAN PROPERTY, NJ.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-196769/AS. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/ROD/R02-88/073. September 1988. 111p, 8 fig, 7 tab.

Descriptors: *Cleanup operations, *New Jersey, *Path of pollutants, *Soil contamination, *Superfund, *Volatile organic compounds, Chromium, Costs, Decontamination, Excavation, Incineration, Lead, Metals.

The 43-acre Ewan Property site is located in a predominantly agricultural and residential area of Shamong Township, Burlington County, New Jersey. Private residences are provided domestic water from wells as close as one mile downgradient from the site, drawing from an aquifer that extends from beneath the site. The site is broken into two study areas, Area A and Area B. Area A, consisting of nine acres, is the area of 500 to 8,000 55-gal drums containing hazardous industrial wastes were disposed of in trenches in Area A, and the trenches were subsequentially backfilled with soil. Investigations also revealed that many of the drums are ruptured, corroded or leaking. Soil and groundwater samples indicate the presence of VOCs and metals. It is estimated that Area A has 4,500 sq yd of highly contaminated soil and waste material, and 29,500 sq yd of moderately contaminated soil. Primary contaminants of concern affecting soil and groundwater are VOCs such as benzene, TCE, PCE, and xylenes, and metals including chromium and lead. The selected remedial action for this site includes: construction of decontamination, staging and waste characterization areas; excavation, staging and characterization of waste materials with offsite incineration of all appropriate wastes (approximately 4,500 sq yd of buried drums and heavily contaminated soil); temporary onsite storage and assessment of non-incinerable wastes to determine proper disposal method; and monitoring of air and groundwater during remedial activities. The estimated present worth cost of the selected remedy is $21,153,000 with estimated annual O&M costs of $22,000. (Author's abstract)
W91-03562

SUPERFUND RECORD OF DECISION: DORNEY ROAD, PA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-196745/AS. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/ROD/RO3-88/056. September 1988. 57p, 4 fig, 6 tab.

Descriptors: *Cleanup operations, *Groundwater pollution, *Path of pollutants, *Pennsylvania, *Soil contamination, *Superfund, *Volatile organic compounds, Arsenic, Chromium, Costs, Landfills, Leachates, Metals, Phenols.

The Dorney Road Landfill site is located in Lehigh County, Pennsylvania. The site is approximately 27 acres, bounded on the east by Dorney Road, and extends westward such that the southwest corner is in Longswamp Township, Berks County. Land use in the area is rural, residential and agricultural. The population within an 0.25 mile radius of the site is estimated to be approximately 20 people. Currently, 1 residence is located within 1,000 feet of the site and 3 residences are within 2,000 feet of the site. The water supply for these nearby homes is groundwater from private wells. The majority of the site is presently owned by R. Emory Mabry. Beginning in 1952, an abandoned iron mine pit on the site was used as an open dump. From 1966 to 1978, an unpermitted landfill was operated in the same mine pit. In 1986, EPA conducted a removal action and regraded the landfill to prevent runoff and erosion of landfill material from migrating to neighboring property. In 1980 and 1982, EPA investigations revealed elevated levels of VOCs, metals and phenols in groundwater and leachate-samples. This remedial action will prevent dermal contact and incidental ingestion of landfill soil and solid waste. It will also minimize the continued leaching of precipitation and onsite ponded waters through the contaminated landfill. A subsequent remedial action will address the groundwater under the site. The primary contaminants of concern affecting the soil, groundwater and surface water are VOCs including benzene, toluene and xylenes, metals including arsenic and chromium, and other organics including phenol and PAHs. The selected remedial action for this site includes: offsite disposal of approximately 700,000 gallons of onsite pond water; construction of a dike and diversion ditch system to control runon/runoff; regarding and installation of a multilayer landfill cap and a gas collection system; groundwater monitoring; and deed and access restrictions. The estimated present worth cost for this remedial action is $14,000,000 with estimated annual O&M costs of $42,000. (Author's abstract)
W91-03563

SUPERFUND RECORD OF DECISION: G.E. WIRING, PR.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB189518/AS. Price codes: AO3 in paper copy, AO1 in microfiche. Report No. EPA/ROD/RO2-88/069. September 1988. 36p, 6 fig, 2 tab.

Descriptors: *Cleanup operations, *Groundwater pollution, *Mercury, *Path of pollutants, *Puerto Rico, *Superfund, Costs, Industrial wastes, Remedial action plans, Soil contamination.

The GE Wiring Devices site is located in Juana Diaz, Puerto Rico. The General Electric Company (G.E.) owns and operates a five-acre wiring devices plant at this site, which assembled silent mercury switches from 1957 until 1969. Approximately half a ton of mercury was discarded along with 4,000 cu yd of defective switch parts and plastic scraps in an onsite waste-fill area about 1 acre in area and 1 to 4 feet deep. Several residences are located approximately 400 feet south of the waste-fill area, which is surrounded by a concrete retaining wall and a fence. Groundwater in the area is used as a source of drinking water with a public supply well located approximately 1,500 feet west of the waste-fill area. In addition, groundwater flows to the west toward the San Jacaquas River. About 500,000 gallons of perched water has accumulated within the waste-fill area as a result of precipitation/recharge. Evidence indicates that contamination of the water table is occurring due to the migration of perch water through the clay layer that exists beneath the waste-fill area. Approximately 1,500 cu yd of near-surface soil south and downgradient of the waste-fill area has been contaminated by mercury primarily as a result of previous surface runoff from the plant area. The primary contaminant of concern affecting the groundwater, soil, and debris is mercury. The selected remedial action for this site includes: onsite hydrometallurgical treatment of the waste-fill materials, perched water, and contaminated near-surface soil with disposal of the treatment residue in the former waste-fill area, followed by covering with a clean soil cover, and onsite treatment of the process leaching agent with discharge to a publicly-owned treatment works; additional investigation of the groundwater to determine the extent of contamination; and limited groundwater monitoring, provided there is no need for groundwater remediation. The estimated capital cost for this remedial action is $1,912,870. There are no O&M costs associated with this remedy. (Author's abstract)
W91-03565

SUPERFUND RECORD OF DECISION: NL/TARACORP/GOLDEN AUTO, MN.
Available from the National Technical Information Service, Springfield, VA 22161, as PB189542/AS. Price codes: AO3 in paper copy, AO1 in microfiche. Report No. EPA/ROD/RO5-88/077. September 1988. 30p, 4 fig.

Descriptors: *Cleanup operations, *Groundwater pollution, *Industrial wastes, *Lead, *Minnesota, *Path of pollutants, *Soil contamination, *Superfund, Asphalt capping, Drinking water, Monitoring, Soil remediation.

The NL/Taracorp/Golden Auto Parts site is located in St. Louis Park, Hennepin County, Minnesota. A secondary lead smelting facility operated onsite from 1940 until 1982. Land use adjacent to the site is light industry. There are residental areas within 0.25 mile of the site to the north, east, and west. Aquifers beneath the site serve as primary sources of drinking water in the area, supplying 90 percent of all groundwater used in the region. The site was originally owned by NL Industries, Inc., but was later divided and each portion sold to a succession of owners. One of these owners, Taracorp, owned and operated the lead smelting facility from August 1979 until February 1981. Secondary lead smelting operations recovered lead from lead plates, battery fragments, and lead containers. The industrial operations and onsite waste disposal activities resulted in elevated lead levels in air and onsite soil. Under a Consent Order, NL conducted onsite investigations and cleanup activities between 1985 and 1988 including soil remediation, capping the site with asphalt, and establishing a long-term groundwater monitoring program. As part of the Consent Order, NL was also required to investigate and, if necessary, clean up soil near the site possibly contaminated by windblown contaminants. This remedial action addresses the possibility of offsite soil contamination. Investigations indicate that offsite soil does not contain elevated levels of lead attributable to the site. There are no contaminants of concern attributable to the site affecting the offsite soil. The selected remedial action for this site is a no action remedy. The one residential yard that exceeds state and ATSDR

guidance levels for soil lead is not clearly attributable to the site, but will be addressed through a cooperative cleanup by NL Industries. There is no capital cost or O&M associated with this remedial action. (Author's abstract)
W91-03566

SUPERFUND RECORD OF DECISION: BROWN WOOD PRESERVING, FL.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-104795/AS. Price codes: AO in paper copy, AO1 in microfiche. Report No. EPA/ROD/RO4-88/034. April 1988. 358p, 3 fig, 7 tab.

Descriptors: *Cleanup operations, *Creosote, *Florida, *Groundwater pollution, *Path of pollutants, *Soil contamination, *Superfund, Biodegradation, Costs, Offsite disposal, Organic compounds, Polycyclic aromatic hydrocarbons.

The 55-acre Brown Wood Preserving Site is located approximately two miles west of the City of Live Oak, Suwannee County, Florida. The site is located in karst terrain in which sinkholes are a common geological feature. The areas surrounding the site are considered rural and light agricultural. There are four private wells located along the site periphery that obtain water from an aquifer 20-100 feet below the site. The public water supply wells for the City of Live Oak are located less than two miles away. The site contains a former wood preserving plant facility, which pressure treated timber products with creosote and some pentachlorophenol (PCP) for thirty years between 1948 and 1978. During this time, several different companies operated the facility. In addition, the facility was rebuilt following a fire in February 1974. Sludge and contaminated soils have been identified in the immediate vicinity of the plant site and an upgradient lagoon. This three-acre lagoon drains approximately 74-acres and contains water provided above approximately 3,000 cu yds of creosote sludge and contaminated soil. In addition, small amounts of solidified creosote and PCP are contained in onsite storage tanks and retorts. In 1981, EPA was notified by one of the former facility owners that hazardous waste may have been handled at the site. In July 1982, the Florida Department of Environmental Regulation (FDER) inspected the site and detected a number of organic compounds. An action, completed in February 1988, resulted in the removal of approximately 200,000 gallons of lagoon water and 15,000 tons of contaminated lagoon sludge and soil. The primary contaminants of concern affecting the soil, sediments, sludge, and wastewater are creosote constituents including Polycyclic aromatic hydrocarbons. The selected remedial action for this site includes: removal and treatment, if necessary, of lagoon water with discharge to a publicly-owned treatment works; excavation, treatment, and offsite disposal of approximately 1,500 tons of the most severely contaminated soil and sludge; onsite biodegradation of approximately 10,000 tons of the remaining soils in a 14-acre treatment area constructed with a liner and an internal drainage and spray irrigation system; covering of the treatment area with clean fill after bioremediation; and groundwater monitoring. The estimated present worth cost for this remedial action is $2,740,000. (Author's abstract)
W91-03567

ANIMAL WASTE POLLUTION AND ITS CONTROL (JAN 70-JUN 89). CITATIONS FROM THE NTIS BIBLIOGRAPHIC DATABASE.
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 10C.
W91-03573

HEALTH ASSESSMENT FOR WHITTAKER CORPORATION NATIONAL PRIORITIES LIST (NPL) SITE, MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA, REGION 5, CERCLIS NO. MND006252233.
Agency for Toxic Substances and Disease Registry, Atlanta, GA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-100314/AS. Price codes: AO3 in paper copy, AO1 in microfiche. 1989. 13p. 3 ref.

Descriptors: *Cleanup operations, *Hazardous wastes, *Industrial wastes, *Minneapolis, *Public health, Industrial coatings, Remediation, Resins, Volatile organic compounds.

The Whittaker Corporation Site is a National Priorities List site located in Minneapolis, Hennepin County, Minnesota. Resins and industrial coatings are manufactured at the site. Without remediation, the site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at unknown concentrations which, if elevated, may result in adverse human health effects. Human exposure to VOCs may occur via inhalation of contaminants in off-site soils, groundwater, and air and ingestion of and dermal contact with contaminants in off-site and groundwater. Recommendations include: providing adequate personal protective equipment for remediation workers; prevention of the installation of water supply wells into the contaminated aquifers; monitoring of wells until remediation is completed; and possible off-site transport of hazardous contaminants. (White-Reimer-PTT)
W91-03574

SURVEY REPORT: STATE ACTIVITIES TO PROTECT GROUND WATER FROM PESTICIDES.
Virginia Univ., Charlottesville. Div. of Urban and Environmental Planning.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-203954/AS. Price codes: AO6 in paper copy, AO1 in microfiche. Report No. 600/9-89/053. August 1988. 114p.

Descriptors: *Environmental management, *Groundwater pollution, *Groundwater quality, *Pesticides, *Regulations, *Water pollution control, *Water pollution prevention, Drinking water, Economic aspects, Monitoring, Training programs.

This report is part of the National Network for Environmental Management Studies conducted under the auspices of the Office of Cooperative Environmental Management, U.S. Environmental Protection Agency. It presents the results of a survey, conducted in the summer of 1988, to determine what states are doing to protect groundwater from pollution by pesticides. The report also highlights a variety of methods used by the states to finance their programs. Major components of state activities to protect groundwater may include: (1) an official groundwater protection strategy; (2) a pesticide management plan; (3) groundwater monitoring for pesticides; (4) regulatory programs; (5) groundwater classification; (6) pesticide user education; and (7) integrated pest management. State monitoring for pesticides in groundwater ranges from extensive ongoing programs to limited sampling in response to complaints or suspected problems. Regulatory programs include: groundwater quality standards for pesticides; the use of maximum containment levels (MCLs) to protect current or potential drinking water sources; requirements for specific control devices; regulation of distribution, sale, handling, storage, disposal and use of pesticides. Non-regulatory programs play a major role in many states' efforts to protect their groundwater from pesticides by: conducting seminars and voluntary training sessions for users of pesticides; developing integrated data systems; and integrating pest management and well head protection. A few states are working toward developing the capacity to overly groundwater vulnerability information with pesticide usage data in order to pinpoint potential groundwater contamination problems. The survey report will be used by EPA Headquarters and Regional personnel to prepare for presentations before states and their audiences. Kept in a looseleaf folder, the summaries can be separately revised as new information becomes available. (Author's abstract)
W91-03575

ADVANCED UTILITY SIMULATION MODEL, ANALYTICAL DOCUMENTATION, STATE LEVEL MODEL (VERSION 1.0).
Illinois Univ. at Urbana-Champaign. Coll. of Engineering.
For primary bibliographic entry see Field 7C.
W91-03581

SUPERFUND RECORD OF DECISION: OLD SPRINGFIELD LANDFILL, VT.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-204754. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA/ROD/R01-88/033, September 1988. 215p, 3 fig, 12 ref, append.

Descriptors: *Cleanup operations, *Landfills, *Old Springfield Landfill, *Superfund, *Vermont, *Water pollution sources, Costs, Industrial wastes, Leachates, Municipal wastes, Organic compounds, Polychlorinated biphenyls, Site remediation, Tetrachloroethene, Trichloroethene, Waste disposal.

The Old Springfield Landfill site is located approximately one mile southwest of the city center in Springfield, Windsor County, Vermont. The landfill was operated by the Town of Springfield between 1947 and 1968 for the disposal of municipal solid waste and hazardous industrial liquid and semi-liquid waste. The site is currently owned by Springfield Mobile Home Estates, which operates a trailer park currently consisting of 38 mobile homes. Approximately 60 people reside in the Springfield Mobile Estates trailer park, built on top of the landfill. The site first came to the attention of the Vermont Department of Health because of a complaint by a nearby resident of foul-smelling water. Investigation of the site found volatile organic compound (VOC) contamination in a spring and in a residential well near the mobile home park. EPA began investigations at the site in 1976. Four areas of contamination have been identified at the site where industrial waste was either disposed of in discrete trenches or mixed with the municipal waste. This remedial action addresses landfill seepage and groundwater contamination. The remedial action is designed for management of contaminant migration and study of final remediation alternatives. The primary contaminants of concern affecting the groundwater, soil, and sediments are VOCs including benzene, tetrachloroethene, trichloroethene, toluene, and other organics including polychlorinated biphenyls and polycyclic aromatic hydrocarbons. The selected remedial action for this site includes: construction of an underground collection system to collect leachate; installation of wells for extraction of contaminated groundwater; onsite treatment of the collected leachate and extracted groundwater, or discharge to the Publicly Owned Treatment Works for treatment; institutional controls; and conducting additional studies to determine the feasibility of isolating water materials from the groundwater (e.g., french drain, slurry wall, or waste removal). The estimated present worth cost for this remedial action in $5,374,000 with annual O&M costs of $173,000. (Author's abstract)
W91-03586

SUPERFUND RECORD OF DECISION: WILDCAT LANDFILL, DE.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-196752. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/ROD/R03-88/052, June 1988. 56p, 10 fig, 2 tab, 2 append.

Descriptors: *Cleanup operations, *Delaware, *Landfills, *Superfund, *Water pollution sources, *Wildcat Landfill Site, Benzene, Costs, Groundwater pollution, Heavy metals, Industrial wastes, Latex, Monitoring, Polychlorinated biphenyls, Site remediation, Volatile organic compounds, Waste disposal.

The Wildcat Landfill site is located 2.5 mi southeast of Dover in Kent County, Delaware. The 44-acre site is bordered to the north and east by the St. Jones River and its associated wetlands, and to the south and west by residential and commercial developments. A pond created by construction of the landfill, is located directly adjacent to the site along the northwestern edge. The pond is the subject of a second operable unit for the site. Portions of the site lie within the 100-year floodplain of the St. Jones River. The site was operated as a permitted sanitary landfill between 1962 and 1973, accepting both municipal and industrial wastes. Industrial wastes suspected to have been disposed include latex waste and paint sludges. Throughout its 11 years of operation, the facility routinely violated operating and other permits issued by regulating agencies. EPA began investigating the site in 1982. Typical wastes encountered at the site included municipal refuse latex in strips and sheets; scattered crushed, empty, or intact drums; and manufactured plastic items. Much of the waste is located on low-lying wetland. Consequently, in that area of the landfill, wastes are in direct contact with the, surficial sand aquifer. The primary contaminants of concern affecting the soil and groundwater are volatile organic compounds including benzene, other organics including PCBs, and metals including arsenic and lead. The selected remedial action for this site includes: grading, installation of a soil cover, and revegetation of onsite direct contact risk areas; removal and offsite disposal of drums containing wastes by landfilling (if not hazardous) or incineration (if hazardous); replacement of two domestic wells adjacent to the site; institutional controls including well and land use restrictions; and groundwater monitoring. The estimated present worth cost for this remedial action is $5,400,000. (Author's abstract)
W91-03587

WATER POLLUTION ABATEMENT EXPENDITURES IN THE WISCONSIN PAPER INDUSTRY.
Wisconsin Univ.-Madison.
T. B. Petersen.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-189765. Price codes: A04 in paper copy, A01 in microfiche. EPA Report No. 600/9-89/017, 1988. 48p, 5 fig, 7 tab. EPA Grant No. U-912840.

Descriptors: *Costs, *Pulp and paper industry, *Water pollution control, *Wisconsin, Alabama, Comparison studies, Dioxins, Economic aspects, Georgia, Industrial wastewater, Polychlorinated biphenyls, Standards, Wastewater treatment.

This study estimates the costs incurred by paper mills in the State of Wisconsin to comply with water pollution control requirements, and compares these costs to those incurred by similar mills in other states. Compared to 1965, discharges of conventional pollutants from Wisconsin's 47 paper mills have been reduced by about 90%. Current operating costs for treatment systems at Wisconsin paper mills are approximately $60 million annually. Paper mills in Georgia and Alabama spend less for wastewater treatment than Wisconsin mills as a result of several differences including: age and size of mills, product mix, production technology, and waste treatment technology. Paper mills in Wisconsin appear to be controlling wastewater discharges more effectively than mills in the other States based on the comparative incidence of discharge permit violations. The focus of wastewater treatment in Wisconsin paper mills is on toxic pollutants, especially dioxins and polychlorinated biphenyls (PCBs). Control of these toxic pollutants, which occur at low concentrations in mill effluent but which bioaccumulate to high concentrations in fish tissue, is costly and controversial. (Author's abstract)
W91-03589

EFFLUENT FEES: POLICY CONSIDERATIONS ON A SOURCE OF REVENUE FOR INFRASTRUCTURE FINANCING.
Yale Univ., New Haven, CT. School of Forestry and Environmental Studies.
P. Casey.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-203780. Price codes: A03 in paper copy, A01 in microfiche. EPA Report No. 600/9-89/051, August 9, 1988. 32p, 2 fig, 17 ref.

Descriptors: *Effluent charges, *Environmental protection, *Financing, *Wastewater facilities, Cost-benefit analysis, Economic aspects, Federal jurisdiction, State jurisdiction, Taxes.

With the phasing out of EPA's construction grants program and the implementation of State Revolving Funds (SRF's), it appears that more money will be needed for the financing of wastewater treatment facilities in the next twenty years. Infrastructure needs for wastewater treatment facilities will increase significantly due to required replacement and upgrading needs, while users fees may be significantly understated due to years of capital subsidies. With Federal seed capital for the SRF's stopping after 1994, alternative sources of funding will be necessary. An effluent fee program could both offer a way to make the polluter pay and provide a reliable financing mechanism for the SRF's. This paper discusses the experience of effluent fees in Europe, and proposes an effluent fee program that would provide needed capital to the State Revolving Fund. The fee would be tied into the National Pollutant Discharge Elimination System permits through gradual implementation. Various options for settling the fee and enforcement procedures are also discussed. (Author's abstract)
W91-03592

IN SITU AQUIFER RECLAMATION BY CHEMICAL MEANS: A FEASIBILITY STUDY.
Illinois State Water Survey Div., Champaign. Aquatic Chemistry Section.
G. R. Peyton, M. H. LeFaivre, and M. A. Smith.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-197123/AS. Price codes: A05 in paper copy, A01 in microfiche. Report no. HWRIC RR-028, September 1988. 91p, 19 fig, 6 tab, 52 ref. HWRIC Project No. HWR86-011.

Descriptors: *Chemical treatment, *Cleanup operations, *Groundwater pollution, *In situ treatment, *Organic pollutants, *Water pollution treatment, Benzene, Feasibility studies, Free radicals, Reclamation.

Cleanup of groundwater contaminated by organic chemicals that adsorb to aquifer solids may require decades if the water is pumped to the surface to be treated by conventional technologies. In site treatment means treatment of the contaminant while it is still in the aquifer. It could conceivably take place at the rate at which the treatment can be transported to the contaminant. Although in situ biotic processes appear promising in many aquifer reclamation applications, chemical in situ reclamation using free-radical processes represents a complementary, and in some respects more general, method of destroying organic contaminants in aquifers. A feasibility study was conducted that demonstrated that chemical in situ aquifer reclamation can be feasible in at least some situations. In one experiment, 58 ppm (in the pore water) of benzene, used as the model contaminant, was 62% destroyed when the experiment was terminated at the end of two months. Reactive free radicals were generated from more stable water-soluble reagents which are pumped to the contamination region. The rate of generation of free radicals was not predictable from batch solution kinetic studies, but was accelerated, apparently due to the presence of promoter substances formed in the reaction of free radicals with soil material. The presence of 50 ppm alkalinity had no detrimental effect on the process. (Author's abstract)
W91-03598

SUPERFUND RECORD OF DECISION: CROYDEN TCE SPILL, PA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-229512. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/ROD/R03-89/066, December 1988. 55p, 2 fig, 7 tab.

Descriptors: *Chlorinated hydrocarbons, *Cleanup operations, *Path of pollutants, *Pennsylvania, *Superfund, *Volatile organic compounds, Industrial wastes, Polychloroethane, Tetrachloroethane, Water pollution.

The Croyden TCE Spill site is located in Bristol Township, Bucks County, Pennsylvania. Volatile organic compound (VOC) contamination in the groundwater has been detected over a 3.5 sq mi area referred to as the study area. The study area is predominantly residential with an estimated 3,000 residents. A small southeastern portion of the study area containing elevated levels of VOCs, particularly TCE, and numerous potential source areas have been identified and are referred to collectively as the 'focused area of investigation.' This smaller area is composed of the Croyden residential community and several manufacturing and commercial establishments. The study area is bordered on the south by the Delaware River. Neshaminy Creek, which borders the study area to the west, and Hog Run Creek which flows through the focused area of investigation, both discharge to the river. Although the source of contamination has not been identified, the contaminant plume appears to be flowing south-southeast into the East Branch of Hog Run Creek and probably into the Delaware River. EPA identified the Croyden site following a series of studies beginning in 1984 conducted on the Rohm & Haas site, an industrial landfill, located on the southern boundary of the site. The primary contaminants of concern affecting the groundwater are TCE and PCE. The selected remedial action for the site includes connecting approximately 13 residences to the public water supply system via the construction of new water services lines, mains, hydrants, and valves; and groundwater monitoring to ensure that homes located outside of the TCE-contaminated zone will not be at risk from the migrating plume. The estimated present worth cost for this remedial action is $106,000 with annual O&M cost of $3,400 for 30 years. (Author's abstract)
W91-03601

SUPERFUND RECORD OF DECISION: ORDOT LANDFILL, GU.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-225569/AS. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/ROD/R09-88/022, September 1988, 44p, 2 fig, 2 tab, append.

Descriptors: *Groundwater pollution, *Guam, *Landfills, *Superfund, *Water pollution control, Drinking water, Hazardous wastes, Iron, Leaching, Manganese, Public health.

The Ordot Landfill site is located on the Island of Guam. The landfill is in a volcanic upland region, where site runoff flows directly into the adjacent Lonfit River. Water wells have not been drilled in the volcanics near the landfill. There is concern, however, that a suspected fault near the landfill may provide a hydrologic connection between the contaminants at Ordot Landfill and Guam's major drinking water aquifer located in the northern limestone province of Guam. The landfill is presently managed and operated by the Guam Department of Public Works, and has been receiving uncontrolled municipal wastes since before World Water II. Because it is the only major public waste disposal site on Guam it has received some hazardous waste during its history, including spent industrial and commercial chemicals, PCB-contaminated oils from transformers, and perhaps munitions. The facility uses almost the entire 47-acre waste disposal area, with only approximately 4 to 7 acres of the oldest portion of the landfill not currently in use. The current depth of disposed wastes is approximately 100 ft. In March 1986, EPA found Ordot Landfill in violation of the Clean Water Act for discharging landfill leachate to the Lonfit River without an NPDES permit. The 1987 initial site characterization study concluded that surface flow through the landfill is the source of leachate,

the site is hydrologically isolated from the island's sole source aquifer, there is an absence of organic contaminants, inorganic contamination is below the appropriate maximum contaminant limits (MCLs), and no air quality problems exist. The study concluded that current threats to human health and the environment are a result of poor landfill operation practices and not a result of the few acres of the landfill which are no longer in operation. The primary contaminants of concern affecting the groundwater and surface water include iron and manganese. The selected remedial action for this site is the no action alternative. EPA concludes that threats to human health and the environment can best be mitigated through addressing operation and maintenance of the landfill, and that the appropriate mechanism for implementing these controls is through enforcement of the Clean Water Act. Further, EPA concludes that any remedial action to address the inactive portion of the landfill would be jeopardized or nullified unless operation practices at the active disposal areas are improved. No costs are associated with the no action alternative. (Author's abstract)
W91-03607

SECOND CONFERENCE ON THE MANAGEMENT OF THE ILLINOIS RIVER SYSTEM: THE 1990S AND BEYOND.
For primary bibliographic entry see Field 6A.
W91-03608

WATER QUALITY IMPACTS OF ILLINOIS RIVER COMMERCIAL NAVIGATION.
Illinois State Water Survey, Peoria. Water Quality Section.
T. A. Butts, and D. B. Shackleford.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 19-27, 2 fig, 6 tab.

Descriptors: *Algal growth, *Environmental effects, *Illinois, *Illinois River, *Navigation, *Water quality, Barges, Ecological effects, Monitoring.

The Illinois Waterway is subjected to heavy commercial barge traffic. The opportunity to study the possible effects this traffic has on water quality was presented during two months of the summer of 1987, when the U.S. Army Corps of Engineers shut down operations at the Peoria and LeGrange dams for lock repairs. Physical, chemical and biological data were collected prior to the shutdown, during the shutdown, and after reopening during 1987 and during the summer of 1988. The data was rigorously analyzed using mathematical statistical procedures with the results revealing that in general, barge traffic does not appear to affect long-term water quality. Water clarity, as indicated by turbidity, suspended solids, and Secchi disk readings was better during 1988 when barge traffic was normal than during 1987 when the Peoria pool was not subjected to normal traffic. The significantly lower DOs during the summer of 1988 can be attributed to record high temperatures and persistent low flows rather than normal summer barge traffic. Barge traffic did not appear to have a marked effect on benthic macroinvertebrates since densities, diversity, and species numbers were greater during corresponding periods of 1988 than during 1987. Overall pool sediment conditions appeared comparable during both years, however, some localized changes may have occurred, particularly in the deep channel areas immediately above the two dams. Only algae densities appeared to be affected to some degree by barge traffic. The geometric mean of the algae density during 1988 was less than half of that encountered in 1987. The reason for such a reduction without a commensurate reduction in water quality is unclear at this time. However, if barge movement intrinsically keeps algal growth down, this could be looked upon as a benefit rather than a detriment. (See also W91-03608) (Lantz-PTT)
W91-03610

COMMENTS FOR ILLINOIS RIVER CONFERENCE PEORIA, OCTOBER 3-4, 1989.
Illinois State Water Survey Div., Champaign.
R. G. Semonin.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 41-45.

Descriptors: *Environmental effects, *Illinois, *Illinois River, *Management planning, *Peoria Lake, *Sedimentation, *Water quality, *Water resources management, Environmental protection, Public policy, Water quality management, Water resources development, Watershed management.

A rare opportunity is available to define and manage the future of the river with the support and encouragement of the people who work, live, and recreate along and on its waters. Movement must be made toward developing the best possible management programs for the river and its lakes, and to improve the environmental and ecological integrity of the river and lake areas. Peoria Lake must be viewed as a part of the Illinois River rather than as a separate entity; whatever is down to the Lake is down to the River and vice versa. Any programs established for the lake must be compatible for the river also, and must include the entire river basin. A comprehensive management plan for Peoria Lake must include two major components: (1) control of sediment input to the lake is essential; and (2) the disposition of the sediment in the lake and along its shoreline must be carefully considered. Major findings in recent Peoria Lake studies have found: (1) The lake had lost 68% of its 1903 capacity by 1985; (2) The average depth of the lake was reduced from 8 feet in 1903 to 2.6 ft in 1985; (3) The sediment rate in Peoria Lake is highest among the large reservoirs and lakes in Illinois; (4) The sedimentation rate in the upper lake is higher than in the lower lake; (5) The sediment rate in recent years has been higher than in earlier years; (6) The annual capacity loss is 2,000 acre-feet; and (7) The annual sedimentation rate is 2 million tons of sediment. (See also W91-03608) (Lantz-PTT)
W91-03613

PEORIA LAKE SEDIMENTATION AND PROPOSED ARTIFICIAL ISLANDS.
Illinois State Water Survey Div., Champaign.
M. Demissie.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 46-57, 6 fig, 2 tab, 9 ref.

Descriptors: *Artificial islands, *Illinois, *Lake restoration, *Peoria Lake, *Reservoir silting, *Reservoirs, *Sedimentation, Dredging, Islands, Lake sediments, Navigation, Recreation, Sedimentation rates.

Sedimentation in Peoria Lake has occurred at two distinct rates. For the period from 1903 to 1965, the sedimentation rate for Peoria Lake 0.63%/yr, which is relatively high but within the range for sedimentation rates for other large lakes and reservoirs in Illinois. The sedimentation rate for the period from 1965-1985 was 1.44%/yr, which is more than double the rate of the previous period and by far the highest sedimentation rate among the large lakes and reservoirs in Illinois. As sedimentation continues at the present rate, much of the lake outside of the navigation channel will be transformed into mudflats and wetland areas that will be flooded annually. The need for rehabilitation of Peoria Lake is therefore apparent. After evaluating many alternatives, the Illinois State Water Survey recommended a comprehensive plan, the creation of artificial islands by selective dredging of certain areas. The major benefits of selective dredging and island construction in Peoria Lake could include: (1) Improved and diversified aquatic and riparian habitats; (2) Dredged material disposal sites for both navigation channel maintenance and selective dredging; (3) Reduction of wind and navigation-induced resuspension of sediment and turbidity; (4) Reduction of sedimentation rates in the areas where islands are constructed; (5) More suitable water-based recreational sites at Peoria Lake. (See also W91-03608) (Lantz-PTT)
W91-03614

HABITAT RESTORATION FOR FISH AND WILDLIFE IN BACKWATER LAKES OF THE ILLINOIS RIVER.
Illinois State Water Survey, Peoria. Water Quality Section.
D. Roseboom, R. Twait, and D. Sallee.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 65-68, 4 ref.

Descriptors: *Backwater effect, *Habitat restoration, *Illinois, *Illinois River, *Lake restoration, *Peoria Lake, Aquatic habitats, Ecosystems, Fish, Fisheries, Recreation, Sedimentation, Wildlife.

The Lake Peoria Habitat Restoration project was sponsored by the Illinois Department of Conservation with Sport Fish Restoration funds to create a fish habitat; the Illinois River and Lake Peoria were once the greatest fishing and hunting areas in Illinois. Excessive rates of sedimentation are destroying Lake Peoria along with all of the backwater lakes of the Illinois River. Concurrent with this increased sedimentation, much of the aquatic vegetation disappeared between 1950 and 1965; high rates of sedimentation buried aquatic vegetation between thick layers of fluid sediments. Wave action prevents natural revegetation by uprooting young plants from the fluid sediments. When the aquatic vegetation died off, populations of waterfowl and game fish declined quickly. The Lake Peoria Restoration project has developed low cost techniques to restore aquatic vegetation. For example, when placed behind a tire breakwater, arrowhead and pondweed plantings have been successful. Both the breakwater and plant beds have survived two winters after initial plantings. The breakwater also serves as an artificial reef. Game fish response has been quick and dramatic. The number of fish species has doubled and the numbers of fish have quadrupled. The vegetated area serve as a nursery for young bluegill, channel catfish and bass. In 1989, large bluegill were found on the vegetated site only. The number and total weight of bluegill and channel catfish in the vegetated area exceeded the number and total weight of all fish (mainly carp) in the control area. (See also W91-03608) (Author's abstract)
W91-03616

BENEFITS OF TARP TO THE ILLINOIS RIVER.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 5D.
W91-03617

ENVIRONMENTAL MANAGEMENT PROGRAM PROPOSALS: THE ILLINOIS BASIN.
Illinois State Dept. of Transportation, Springfield.
B. Donels.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 77-80.

Descriptors: *Environmental effects, *Environmental policy, *Illinois, *Illinois River Basin, *Management planning, *Water pollution control, *Water resources management, Environmental protection, Federal jurisdiction, Habitat protection, Illinois River, Long-term planning, Mississippi River, Monitoring, Peoria Lake, Project planning, Recreation.

The environmental Management Plan, established by Congress in 1986, is composed of 5 program

elements: (1) Habitat improvement projects; (2) Long-term resource monitoring; (3) Recreational projects; (4) Recreation economics study; and (5) Navigation traffic monitoring. The US Army Corp of Engineers implements the Environmental Program. Nine major Environmental Management Program Habitat Improvement Projects are recommended for design and eventual implementation in the Illinois basin. These projects include the Peoria Lake island construction and habitat improvement project; the Banner Marsh Habitat Rehabilitation and Enhancement Project in the LeGrange Pool; The Rice Lake Complex Habitat Rehabilitation and Enhancement--Phase I project in the La Grange Pool; the Chautauqua Lake project in La Grange Pool; the Sanganois Wildlife Area Project; the Alton Pool side channels near the mouth of the Illinois River; the Stump Lake project; the Swan Lake Refuge; and, the Calhoun Point project. (See also W91-03608) (Lantz-PTT)
W91-03618

ILLINOIS RIVER AND PEORIA LAKES: IT'S TIME TO ACT.
Caterpillar Tractor Co., Peoria, IL.
For primary bibliographic entry see Field 6A.
W91-03621

VALUE OF CITIZEN STREAM QUALITY MONITORING AS AN EDUCATIONAL TOOL.
Wheaton Park District, IL.
B. S. McDonald.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 133-138.

Descriptors: *Education, *Illinois, *Monitoring, *Public participation, *Water quality, Aquatic environment, Data acquisition, Ecosystems, Macroinvertebrates, Streams, Training, Water sampling.

Stream Quality Monitoring (SQM) is an educational and data collection tool used by natural resource agencies to promote stream awareness and protection. SQM is based on the analysis of a stream macroinvertebrate population according to their relative tolerance to pollution. By simply looking at a stream's macroinvertebrate population, the general health of the aquatic system can be determined. Over the past few years SQM has gained wide acclaim across the country as an excellent citizen involvement and educational/interpretive program. Concerned citizens, conservation groups, and schools have adopted streams or segments of streams to monitor the quality of the water using this method. Networks of groups working throughout a watershed can help determine problem areas and sometimes are successful at finding the problem source. The equipment is inexpensive and the technique is simple. There is presently an Illinois SQM program being developed for implementation on a statewide basis and should be available by Spring 1990. (See also W91-03608) (Author's abstract)
W91-03624

USEPA PERSPECTIVE ON NONPOINT POLLUTION CONTROL AND WETLANDS FUNCTION.
Environmental Protection Agency, Chicago, IL. Region V.
R. Pepin, T. Davenport, and D. Ehorn.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 171-174.

Descriptors: *Federal jurisdiction, *Illinois, *Nonpoint source pollution, *Regulations, *Water pollution control, *Wetlands, National Pollutant Discharge Elimination, Permits, Water pollution prevention, Water pollution sources.

Historically, the major emphasis on the national water pollution control program has be the controlling and elimination of the discharge of pollutants from point sources. This focus has resulted in drastic reductions of a variety of pollutants through direct elimination under the National Pollutant Discharge Elimination System (NPDES) permit program. As a result of point source control successes, nonpoint source water pollution has emerged more clearly as a major continuing source of pollution to the Nation's waterways, threatening or prohibiting full attainment of water quality goals of the Clean Water Act. The nature, extent and effect of nonpoint source pollution on the waters of the state are assessed. The Region V Wetlands program consists of enforcement, public information and education, advanced identification, state program delegation, and public notice and review of proposals to fill wetlands. As part of a review, the US EPA looks at the technical merit of the proposed standards. US EPA has also issued guidance in the form of two documents: the Water Quality Standards Handbook and the Technical Support Document for Water Quality-Based Effluent Limits. Numeric criteria are quantifiable levels of specific pollutants or classes of pollutants. In the past there was typically one number for a particular pollutant that was not to have been exceeded. This approach failed to take into account possible adverse effects from long-term or repeated exposures. US EPA, therefore, has been recently advocating a two level approach for pollutants: a short-term or acute value, and a long-term, or chronic value. (See also W91-03608) (Lantz-PTT)
W91-03631

NUTRIENT LOADING STATUS OF THE CONESTOGA RIVER BASIN, 1985-1989.
Susquehanna River Basin Commission, Harrisburg, PA. Resource Quality Management and Protection Div.
For primary bibliographic entry see Field 5B.
W91-03647

STATE GROUNDWATER PROTECTION POLICIES: A LEGISLATOR'S GUIDE.
National Conference of State Legislatures, Denver, CO.
L. Morandi.
National Conference of State Legislatures, Denver, Colorado. May 1989. 81p, 4 tab, 22 ref, append. Edited by Sharon Schwoch.

Descriptors: *Environmental protection, *Groundwater policy, *Legislation, *State jurisdiction, *Water pollution prevention, Case studies, Federal jurisdiction, New York, Public policy, Regulations, Wisconsin.

State governments are taking the lead in formulating groundwater protection policy. While executive agencies took the lead in fashioning the initial state groundwater programs, state legislatures have assumed the major responsibility for program development during the past six years. Federal groundwater policy consists of a series of uncoordinated statutes addressing specific sources of pollution--Resource Conservation and Recovery Act (RCRA) and Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)--or groundwater only peripherally--Clean Water Act and Safe Drinking Water Act. It also is comprised of an Environmental Protection Agency (EPA) strategy that emphasizes the predominant role of the states and the need to strengthen their institutional management capacity. There has been significant state legislative activity beginning with passage of Wisconsin's 1983 Act 410. While much of the legislation has been directed at regulating specific discharge sources--primarily agricultural chemicals and underground storage tanks--comprehensive policies capable of integrating a range of pollutants into a single management framework also have been adopted. New York's land use/aquifer protection law served as a blueprint for the 1986 Safe Drinking Water Act amendments that established a federal sole source aquifer protection demonstration program. Nebraska extended the land use management concept to water use management with passage of legislation to minimize irrigation-induced nitrate concentrations in groundwater. Because of the close physical ties between a diverse set of land use activities and groundwater quality, groundwater law will affect a wide range of vested interest groups. Consensus building may be required to supplement the adversarial nature of the legislative process if agreement on complex groundwater policy is to be reached and sustained through policy implementation. Translating legislative intent into administrative action has been an evolutionary process for groundwater. The availability of preventive action limits has provided a tool to define the onset of pollution and control additional degradation regardless of what standard is used as a ceiling. The document is intended to be a practical guide for state legislators as they consider groundwater protection policies. (Lantz-PTT)
W91-03657

ECONOMIC IMPLICATIONS OF GROUNDWATER CONTAMINATION TO COMPANIES AND CITIES.
Freshwater Foundation, Navarre, MN.
For primary bibliographic entry see Field 5C.
W91-03660

WATER AND THE ENVIRONMENT: THE IMPLEMENTATION OF EUROPEAN COMMUNITY DIRECTIVES ON POLLUTION CAUSED BY CERTAIN DANGEROUS SUBSTANCES DISCHARGED INTO THE AQUATIC ENVIRONMENT.
Department of the Environment, Cardiff (Wales). Welsh Office.
Department of the Environment, Cardiff, Wales. Circular 7/89, March 30, 1989. 86p, 2 append.

Descriptors: *Environmental protection, *European Economic Community, *Hazardous wastes, *Regulations, *Wales, *Water pollution control, *Water quality control, Aquatic environment, Asbestos, Bioaccumulation, Organic compounds, Standards.

The Secretaries of State for the Environment and for Wales are directed to draw to the attention of the relevant authorities European Community Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community, and those directives made within its framework. These directives provide for the control of the discharge of certain dangerous substances into the aquatic environment. DOE Circular 18/85 of 2 September 1985 instructed and advised water authorities on the implementation of these directives. This Circular up-dates and adds to that advice, partly in the light of new directives, and therefore supersedes the previous circular. It also constitutes formal advice on implementing the requirements of certain decisions on the control of dangerous substances under the Paris Convention (on the protection of the North sea from pollution from land-based sources) which closely mirror the requirements of these directives. This circular also instructs competent authorities on the implementation of the relevant provisions of directive 87/217/EEC on the prevention and reduction of environmental pollution by asbestos, which does not fall within the framework of directive 76/464/EEC. The Annex to Directive 76/464/EEC comprises a list of families and groups of dangerous substances, selected mainly on the basis of their toxicity, persistence and bioaccumulation (List I), and a separate list (List II) of substances that can also have deleterious effects on the aquatic environment, which may, however, 'be confined to a given area and which depend on the characteristics and location of the water into which they are discharged'. Article 2 of the directive requires that Member States take steps to eliminate pollution by List I substances and to reduce pollution by List II substances. The Directive provides for different methods of control for List I and List II substances, although in each case it is a basic requirement that discharges to the aquatic environment must be authorized and emission standards laid down. (Lantz-PTT)
W91-03661

GREAT LAKES: LIVING WITH NORTH AMERICA'S INLAND WATERS.

For primary bibliographic entry see Field 2H.
W91-03672

AGENDA FOR THE MANAGEMENT OF THE GREAT LAKES ON A LONG TERM ECOSYSTEM BASIS.
Cornell Univ., Ithaca, NY.
For primary bibliographic entry see Field 6E.
W91-03675

REMEDIAL ACTION PLANS: A GREAT LAKES PROGRAM WHOSE TIME HAS COME.
International Joint Commission-United States and Canada, Windsor (Ontario).
For primary bibliographic entry see Field 6B.
W91-03677

MANAGEMENT OF LAKE ONTARIO RESOURCES: A HOLISTIC PERSPECTIVE.
State Univ. of New York at Buffalo.
For primary bibliographic entry see Field 2H.
W91-03678

CHICAGO AND ITS LAKEFRONT: LIVING ON THE EDGE.
Chicago Shoreline Protection Commission, IL.
For primary bibliographic entry see Field 6G.
W91-03679

UNITED STATES NONPOINT SOURCE PHOSPHORUS REDUCTION EFFORT.
Environmental Protection Agency, Chicago, IL. Region V.
R. Christensen, T. E. Davenport, and B. A. Kirschner.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 173-177, 4 tab, 2 ref.

Descriptors: *Governmental interrelations, *Great Lakes, *Lake management, *Phosphorus, *Water pollution control, *Water quality management, *Water resources management, Eutrophication, Farm wastes, Interagency cooperation, Lake Erie, Lake Ontario, Municipal wastewater, Nonpoint pollution sources, Nutrient removal, Pollution load, Regulations, Water quality control, Water quality standards.

A general framework for reducing phosphorus loadings to the Great Lakes was set forth in Annex 3 of the Great Lakes Water Quality Agreement of 1978. This document established base and future phosphorus loads for each of the Great Lakes, presenting a general plan for decreasing eutrophication and improving water quality in the Lakes system. The governments of the U.S. and Canada were to confirm these target loads within 18 months of signing the agreement. In 1983, a Supplement to Annex 3 was developed and approved, providing a more detailed plan for reducing phosphorus by confirming the load reduction goals set in the original Annex document and by determining that further reductions would be needed after municipal treatment plants had achieved the required phosphorus load reductions. The Supplement recommended annual load reductions for each of the Great Lakes and for several key embayments over a five-year period ending in 1990. The Supplement placed special emphasis on reducing phosphorus loadings to Lake Erie, Lake Ontario, and Saginaw Bay. In order to achieve these target goals, each state and province was required to develop and implement a detailed phosphorus load reduction plan for each waterbody in question. The purpose of the state plans was to ensure that each state would achieve full compliance with point source discharge limits and that agricultural phosphorus loads were reduced through conservation tillage and improved nutrient management. The allocation of load reductions among states primarily reflects the potential in each state for reducing phosphorus loading to each waterbody in question. The State Phosphorus Reduction Plans were consolidated in the overall U.S. Plan. (See also W91-03672) (Author's abstract)
W91-03691

PHOSPHORUS LEVELS IN ONTARIO STREAMS TRIBUTARY TO THE GREAT LAKES A DECADE AFTER PLUARG.
Ontario Ministry of the Environment, Toronto.
For primary bibliographic entry see Field 5B.
W91-03695

LAKE MICHIGAN TOXIC POLLUTION CONTROL/REDUCTION STRATEGY.
Environmental Protection Agency, Chicago, IL. Region V.
K. A. Fenner, and T. E. Davenport.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 221-226, 1 tab.

Descriptors: *Clean Water Act, *Great Lakes, *Lake Michigan, *Lake management, *Water Quality Act, *Water pollution control, *Water quality management, *Water resources management, Environmental policy, Governmental interrelations, Illinois, Indiana, Interagency cooperation, Lake restoration, Michigan, Model studies, Wisconsin.

Two goals in both the Clean Water Act and the 1978 Great Lakes Water Quality Agreement are: to restore, protect, and enhance the physical, chemical, and biological integrity of the Great Lakes. Lake Michigan is the largest body of fresh water totally within the borders of the U.S. It is used by millions as a drinking water supply and for recreation, such as boating, swimming, and sport fishing. It is also an important commercial fishery and transportation resource. At present however, lake uses are impaired because of the concentration of toxic pollutants found in its waters, sediments, fish, and birds. In recognition of these facts, Region V of the U.S. Environmental Protection Agency (EPA) and the states of Illinois, Indiana, Michigan, and Wisconsin have agreed to work together to end the Lake's toxic substance pollution problem. The Lake Michigan Toxic Pollutant Control/Reduction Strategy has been prepared as an implementation plan to eliminate toxic pollutant problems from the Lake Michigan system. The Strategy proposes a two-phase process to guide restoration efforts beginning in 1986. Phase 1 is intended to define, quantify, and control the major sources of pollutants of concern (POCs) to Lake Michigan (1986-1991), and Phase 2 is designed to use models to determine if further controls are necessary. Region V Water Division established an intra-agency, multimedia workgroup to facilitate and track implementation of the Strategy within the EPA. Implementation of this Strategy will be closely coordinated with the Great Lakes Governors' Toxic Control Agreement and The Water Quality Act of 1987. (See also W91-03672) (Fish-PTT)
W91-03696

NONPOINT POLLUTION: 1988-POLICY, ECONOMY, MANAGEMENT, AND APPROPRIATE TECHNOLOGY.
Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. 314p. Edited by V. Novotny.

Descriptors: *Economic aspects, *Environmental policy, *Nonpoint pollution sources, *Water policy, *Water pollution control, *Water pollution sources, *Water resources management, Governmental interrelations, Groundwater quality, Land use, Legal aspects, Management planning, Political aspects, Storm water management, Technology, Watershed management.

Pollution control is an enormous political and legal challenge. In the United States the Commerce Clause of the Constitution, in a strange process, constitutes the legal and political foundation of the point source control. It was reinterpreted as giving authority to the Federal Government to control point discharges of pollution into navigable waters. Unfortunately, the point source definition covered only about 50 percent of pollution loads. The rest originated from diffuse (nonpoint) sources for which controls are difficult to legislate and implement. Nonpoint pollution is generally caused by use and misuse of the land. In the last 15 years, various means of controlling nonpoint pollution have been developed which are generically known as 'Best Management Practices.' A political and institutional mechanism is emerging to implement these practices wherever surface or groundwater quality is impaired. The Nonpoint Pollution Symposium contains papers that are devoted primarily to nontechnical issues and to the solutions of nonpoint pollution abatement programs and they also contribute to the discussion on the nontechnical topics of diffuse pollution abatement. They are generally grouped into the categories: policies of nonpoint pollution abatement; economics, economic efficiency, and equity of the programs; NPS abatement programs--institutions and regional, state, and watershed approaches; urban stormwater management--legal and institutional aspects; innovative approaches to urban stormwater management; and surface and groundwater quality impact of diffuse pollution and its mitigation. (See W91-03705 thru W91-03736) (Fish-PTT)
W91-03704

FEDERAL ENVIRONMENTAL LEGISLATIVE PROCESS.
Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 6E.
W91-03705

GROUNDWATER QUALITY: THE ROLE OF AGRICULTURAL POLITICS AND POLICY.
Iowa Univ., Iowa City. Dept. of Geography.
For primary bibliographic entry see Field 6E.
W91-03706

GROUND WATER POLICY OF USDA.
Department of Agriculture, Washington, DC.
For primary bibliographic entry see Field 6E.
W91-03707

REDUCING NITROGEN POLLUTION FROM CROP PRODUCTION SYSTEMS: A WATERSHED PERSPECTIVE.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
P. E. Norris, and L. A. Shabman.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 29-38, 1 tab, 17 ref.

Descriptors: *Crop production, *Nitrogen compounds, *Nonpoint pollution sources, *Water policy, *Water pollution control, *Water pollution sources, *Water resources management, *Watershed management, Agricultural chemicals, Agricultural practices, Farm wastes, Farming, Fertilizers, Groundwater pollution, Groundwater recharge, Nutrient transport, Reforestation, Riparian land, Riparian vegetation, Surface-groundwater relations.

There are two complementary strategies that promise to reverse the trends in nitrogen (N) pollution identified over 25 years ago, when viewed from a whole watershed perspective. Most generally, these can be described as (1) substitution of inputs in farm production systems, and (2) selective and targeted reforestation of cropland along water bodies. The input substitution strategy seeks to reduce the total amount of commercially manufactured N fertilizer applied to cropland. Commercially manufactured fertilizer is highly susceptible to runoff and leaching. Substitutes for one time application of commercial N fertilizer may be any combination of the following: substitute planting of winter cover crops and rotation changes to serve as N sinks and sources; and substitute animal waste from beef, poultry and hog production systems. Promoting adoption of the necessary substitutions in farming systems will be the policy challenge facing water quality managers and will take water quality management beyond the typical agricultur-

al nonpoint source control programs that are now in place. A cropland reforestation strategy, as a complement to input substitution, would seek to increase the extent of wooded riparian habitat along stream bodies. There is substantial evidence that such wooded habitat can be an effective trap for nutrients carried in surface water runoff and in groundwater recharge to surface waters. Management of riparian woodlands through selective harvesting may, in turn, increase N uptake by the trees. Combining the forested woodland buffer with changes in farm production systems could increase the reliability of either system taken separately as an effective N pollution management strategy. (See also W91-03704) (Fish-PTT)
W91-03708

ECONOMIC IMPLICATIONS OF THE FOOD SECURITY ACT OF 1985'S DISCRETIONARY ENVIRONMENTAL PROVISIONS.
Economic Research Service, Washington, DC.
For primary bibliographic entry see Field 6E.
W91-03710

NONPOINT POLLUTION POLICIES AND POLITICS: THE ROLE OF ECONOMIC INCENTIVES.
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
J. B. Braden.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 57-65, 13 ref.

Descriptors: *Economic aspects, *Economic incentives, *Environmental policy, *Nonpoint pollution sources, *Political aspects, *Water policy, *Water pollution control, *Water quality control, *Water resources management, Alternative planning, Compliance, Cost-benefit analysis, Design standards, Effluent charges, Fines, Permits, Regulations, Subsidies, Water pollution sources.

Economic incentives have been utilized to a remarkable extent already in diffuse source pollution control programs. But, those programs have a long way to go, and economic incentives can contribute far more than they have to date. Four specific forms of economic incentives and their potential to contribute to nonpoint pollution abatement were considered: (1) fees for polluting inputs; (2) fines and 'alternative controls' combined with design standards; (3) further applications of cross compliance; and (4) abatement subsidies. Subsidies are not a viable primary instrument for diffuse source pollution abatement program. They are too costly and subject to perversion. Far more appropriate incentives will result if more responsibility for abatement is placed on polluters. In the nonpoint source case, there seems to be little option but to do this through design standards that, if complied with by all, would accomplish desired objectives for ambient water quality. The design standards would provide a basis for considering alternative control systems both for individuals and as part of a regional 'bubble.' Transferability of permits would provide the incentives to participate in collective strategies and supernormal abatement. In these ways, a fundamentally regulatory system could be made more flexible, individuals would retain some freedom of choice, and collective solutions would be encouraged. (See also W91-03704) (Fish-PTT)
W91-03711

INSTITUTION-SENSITIVE APPROACH TO THE USE OF ECONOMIC INSTRUMENTS FOR NONPOINT SOURCE WATER POLLUTION CONTROL.
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
E. Feitelson.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 67-76, 1 tab, 13 ref, append.

Descriptors: *Economic aspects, *Economic incentives, *Environmental policy, *Land use, *Legal aspects, *Nonpoint pollution sources, *Water pollution control, *Water pollution sources, *Water resources management, Administrative agencies, Alternative planning, Chesapeake Bay, Economic feasibility, Maryland, Nonstructural alternatives, Regulations, Research priorities, Water policy.

Land use controls are often suggested as the primary tool for controlling nonpoint source water pollution. They are limited, however, in dealing with existing land uses and by the U.S. Constitution. They are also criticized on efficiency grounds. Economists often suggest economic instruments as alternatives for regulations, yet the implementation of such instruments has been tentative at best. Literature reviews reveal a number of institution-related issues impeding more extensive use of economic instruments. Economic instruments should complement land use controls for nonpoint source water pollution control. A generalized approach to the choice of economic instruments, if any, is suggested. It is based on answering three questions regarding the goals of the implementing authority, whom it wants to shoulder the burden, its market situation and administrative capabilities. The first two questions define the desirability set out of a general opportunity set of all possible instruments. The latter question defines the feasibility set. The chosen economic instruments will be found in the intersection between the desirability and feasibility sets. Examination of case of the Chesapeake Bay, Maryland, reveals the lack of information regarding institutional desires and the lack of data regarding the minimal requirements for implementing various economic instruments. These are suggested as future research directions. (See also W91-03704) (Author's abstract)
W91-03712

ECONOMICS OF SILVICULTURAL BEST MANAGEMENT PRACTICES.
Forest Service, Atlanta, GA.
G. E. Dissmeyer, and E. Frandsen.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 77-86, 4 tab, 12 ref.

Descriptors: *Best management practices, *Cost-benefit analysis, *Economic aspects, *Forest management, *Nonpoint pollution sources, *Resources management, *Water pollution control, Environmental policy, Land use, Soil management, Water policy, Water resources management.

Implementing best management practices (BMPs) for managing nonpoint sources of pollution is often viewed as a cost with no returns by the majority of forest landowners and managers. However, a national effort by the U.S. Department of Agriculture (USDA) Forest Service found that a wide variety of BMPs can produce positive economic returns to the landowner. For the purposes of this project, the Forest Service policy adopted the concept that the resource activity or program incurring the costs must account for the benefits derived. To be useful to the project, examples had to meet two criteria: (1) investments in soil and water resource management were made; and (2) identifiable induced outputs resulted from implementing soil and water resource management. The project developed five matrices to estimate economic benefits from soil and water resource management for the emphasis areas. Three examples demonstrated the application of these concepts, matrices, and analytical procedures. It was concluded that economic analyses of BMPs provides several positive results: (1) they demonstrate the potential value of implementing BMPs to the landowner and forest operator; (2) induced resource outputs from implementing BMPs can be estimated using interdisciplinary skills and tools; (3) by translating BMP implementation into cost savings, it fosters better communication between nonpoint source pollution managers and forest landowners, foresters, and forest operators; and (4) economic evaluations of BMPs and nonpoint source management projects will identify where they are cost-effective. These procedures will be useful to a variety of governmental agency, industrial, university, and private applications. (See also W91-03704) (Fish-PTT)
W91-03713

EQUITY AND EFFICIENCY ASPECTS OF ALTERNATE STORMWATER MANAGEMENT FINANCING SYSTEMS.
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
G. Lindseyl.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 87-96, 1 tab, 14 ref.

Descriptors: *Cost-benefit analysis, *Economic aspects, *Economic efficiency, *Economic evaluation, *Financing, *Nonpoint pollution sources, *Storm water management, *Urban runoff, *Water resources management, Public policy, Taxes, User charges, Utilities, Water policy.

Although storm water management historically has been regarded as a public good, it has characteristics of private goods as well. Economic theory suggests that gains in efficiency can be achieved by using charges rather than taxes to finance storm water management. Data from a survey of storm water utilities show that most utilities are financed by a combination of user charges and taxes. Data indicate that nonresidential users are more likely than residential users to provide on-site controls in response to charges. Considering this, the use of taxes rather than charges for residential users would tend to resemble the structure that might be imposed by utilities using Ramsey pricing. In a comparison of payments under user charge and property tax systems, it was shown that residential users would pay less under a charge system than under a tax system, while industrial and tax-exempt users, among others, would pay more. It was suggested that user charges may provide opportunities for increases in equity as well as efficiency. Finally, using simple public choice concepts, it was shown that local officials would be likely to support a proposal to a user charge system. (See also W91-03704) (Fish-PTT)
W91-03714

REVENUE SOURCES FOR NONPOINT SOURCE POLLUTION ABATEMENT: AN ECONOMIC ANALYSIS.
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
J. B. Braden, R. L. Farnsworth, J. W. Mill, W. D. Seitz, and D. L. Uchtmann.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 97-106, 14 ref.

Descriptors: *Cost-benefit analysis, *Economic evaluation, *Financing, *Nonpoint pollution sources, *Taxes, *Water pollution control, *Water resources management, Government finance, Illinois, Payment, User charges, Water policy.

Pressure for abatement of nonpoint source pollution is growing. These abatement programs could turn out to be extremely expensive, especially if the 'polluters pay' principle continues to be shunned. Nontraditional revenue sources for nonpoint source pollution abatement include: erosion taxes, fertilizer and pesticide taxes, property taxes and assessments, potable water use taxes and surcharges, recreation license fees, recreation access fees, and excise taxes on recreation equipment and fuel. Where possible, the revenue-generating potential of each was evaluated using illustrative data from Illinois. The results point to potable water surcharges and recreation license fees as particularly promising mechanisms for state governments. Property taxes, special property assessments and potable water surcharges are promising mechanisms for local governments. (See also W91-03704) (Author's abstract)
W91-03715

NONPOINT SOURCE REGULATION--A WATERSHED APPROACH.
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 4D.
W91-03717

IMPLEMENTATION OF THE NEBRASKA NITRATE CONTROL LEGISLATION.
Nebraska Natural Resources Commission, Lincoln.
For primary bibliographic entry see Field 6E.
W91-03719

CREATING SUCCESSFUL PROGRAMS: THE INNOVATIVE TOUCH.
Weston (Roy F.), Inc., Washington, DC.
C. M. Gesalman, A. L. Marasco, and M. Elliott.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 141-148, 3 ref.

Descriptors: *Alternative planning, *Nonpoint pollution sources, *Water policy, *Water pollution control, *Water resources management, Compliance, Financing, Florida, Idaho, Illinois, Interagency cooperation, Iowa, Management planning, Maryland, Minnesota, Oregon, Pennsylvania, Regulations, Technology, Utah, Virginia, Washington, Water pollution sources, Wisconsin.

Concepts and characteristics associated with creative nonpoint source pollution problem solving include formation of unusual partnerships (Tillamook Bay, Oregon; Lake Springfield, Illinois), development of creative funding sources (Utah; Bellevue, Washington; Idaho forests), planning for results (Big Spring, Iowa; Queen Anne County, Maryland), targeting (Wisconsin; Susquehanna River, Pennsylvania; Chesapeake Bay, Maryland), use of new technologies (Virginia; southeastern Minnesota), creative recasting of the problem (Florida), and self-regulation for better compliance (Tillamook Bay, Oregon; Illinois farming; Idaho forests). These concepts might help managers of newer programs save time, money, and energy in solving their own problems, as well as give a boost to programs that may be in need of a new direction or approach. In addition, they are a starting point for gathering information on other creative program approaches. The Environmental Protection Agency and the states are moving into a new phase of the nonpoint source control effort with the initiatives created by the 1987 amendments to the Clean Water Act. New ideas will be needed to solve the current generation of problems. (See also W91-03704) (Fish-PTT)
W91-03720

INTEGRATED RESOURCE MANAGEMENT: REGION V'S NONPOINT SOURCE CONTROL AND CLEAN LAKES PROGRAM.
Environmental Protection Agency, Chicago, IL. Region V.
T. E. Davenport, D. E. Roberts, B. A. Kirshner, and C. E. Loggins.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 149-154, 4 ref.

Descriptors: *Administrative agencies, *Environmental policy, *Lake restoration, *Nonpoint pollution sources, *Water pollution control, *Water resources management, Drinking water, Eutrophic lakes, Farm wastes, Governmental interrelations, Illinois, Lake management, Minnesota, Recreation, South Dakota, Water quality control, Water quality management.

The U.S. Environmental Protection Agency's Region V has thousands of lakes, most of which are located in Minnesota, Wisconsin, and Michigan. These lakes provide drinking water and/or recreational opportunities for millions of people each year. Generally, lakes located in the southern portion of these states have been affected by long-term degradation processes such as runoff from agricultural and urban areas. Historically, the Clean Lakes Program has focused on in-lake measures. While these solutions provide enhanced recreation potential in the short term, they are extremely costly and often do not address the basic causes of eutrophication. The Clean Lakes Program received low levels of funding over the past several years and therefore very few lakes have been rehabilitated. The Region has been involved in 71 individual lake restoration projects as part of the Clean Lakes Program in the last ten years. Some examples which highlight the Regional approach are: Lake Le-Aqua-Na in northwestern Illinois, Clearwater Chain-of-Lakes in Minnesota, and Big Stone Lake on the Minnesota and South Dakota border. In order to increase program participation and accomplishments, Region V will encourage the states to redirect their programs to implement comprehensive solutions. There are many lakes within the Region where management solutions can improve quality. (See also W91-03704) (Author's abstract)
W91-03721

SOUTHEASTERN MINNESOTA COOPERATES TO DEVELOP AN INNOVATIVE APPROACH TO NONPOINT POLLUTION.
Zumbro/Root River Water Quality Task Force, Minnesota.
For primary bibliographic entry see Field 6E.
W91-03722

INTEGRATED EXPERIENCE--THE MILWAUKEE RIVER EAST-WEST BRANCH WATERSHED RESOURCE MANAGEMENT PLAN.
Wisconsin Dept. of Natural Resources, Milwaukee.
For primary bibliographic entry see Field 4D.
W91-03723

STORMWATER PERMITS--A POINT SOURCE UMBRELLA FOR NONPOINT POLLUTION PROBLEMS.
Marquette Univ., Milwaukee, WI. Dept. of Civil Engineering.
V. Novotny.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 173-182, 2 tab, 12 ref.

Descriptors: *Nonpoint pollution sources, *Permits, *Storm water management, *Water pollution control, *Water resources management, Administrative regulations, Economic aspects, Financing, Legal aspects, Regulations, Wastewater disposal, Water policy, Water pollution sources, Water quality control.

Point source pollution has a statutory definition that includes pollution carried by pipes, ditches, channels, tunnels, and concentrated animal operation. In contrast, nonpoint pollution is everything else. In order to enforce or regulate pollution abatement, a 'pointization' of nonpoint sources is legally needed. The present trend is to expand the definition of point sources to the remaining sources in order to make them legally eligible for mandated control. Installing storm sewers is a polluting activity which must be subjected to a permit system. Some problems exist, such as who should pay for pollution abatement and what type of permit is necessary, and several legal and technical (administrative) problems must be resolved. A stormwater permit system is an ambitious pollution abatement program which is unparalleled in scope. If not properly and carefully designed it could become an administrative nightmare. Since it addresses mostly local problems, the financing mechanisms will not be the same as those for point source pollution but abatement may not be as costly. It can be expected that the 'polluter pays' principle will be prevalent. Application of the National Pollution Discharge Elimination System (NPDES) permit system to urban stormwater sources is necessary due to externalities and diseconomics involved and general inefficiency of voluntary approaches. Institutional arrangements for this program are not yet in place and must evolve from existing agencies and programs. Regional solutions and approaches may be needed in water-quality-limited situations. (See also W91-03704) (Author's abstract)
W91-03724

STORMWATER NONPOINT SOURCE POLLUTION CONTROL.
Environmental Protection Agency, Chicago, IL. Region V.
R. G. Newport, and T. E. Davenport.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 183-193, 8 ref.

Descriptors: *Nonpoint pollution sources, *Permits, *Storm water management, *Urban runoff, *Water pollution control, *Water resources management, Cost analysis, Economic aspects, Interagency cooperation, Management planning, Michigan, Pollution load, Storm sewers, Storm wastewater, Water policy, Water pollution sources, Water quality control.

Urban stormwater has been found to include significant quantities of pollutants, and in many areas adversely affects water quality and impairs achievement of designated water resource uses. The Rouge Basin in southeast Michigan is a significant example of a situation where stormwater is contributing to use impairment. To address urban stormwater problems, the U.S. Environmental Protection Agency and state pollution control agencies will be issuing discharge permits to the owner/operators of stormwater collection and conveyance systems and the related outfalls. These permits will require data collection and reporting, and the development and implementation of programs for reducing pollutant loadings to receiving waters. Programs in some cases will call for capital improvements, but in many instances the cost-effective approaches for solving the problems will be Best Management Practices (BMPs). These BMPs will reduce the introduction of pollutants to the storm sewer systems, by managing nonpoint sources (NPS) of pollution. Requiring nonpoint source control components as part of stormwater permits will ensure: (1) that the permits will address all pollutants originating from nonpoint sources; (2) that the BMPs required under the permits will economically control the pollutants identified; and (3) that the NPS control activities identified as being necessary will be fully implemented. This approach is being recommended for use as part of the Remedial Action Plan developed for cleaning up the Rouge River. (See also W91-03704) (Author's abstract)
W91-03725

MARYLAND'S STORMWATER MANAGEMENT PROGRAM.
Maryland Dept. of the Environment, Annapolis. Sediment and Stormwater Div.
R. L. Kort.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 195-201, 7 ref.

Descriptors: *Maryland, *Nonpoint pollution sources, *Storm water management, *Urban drainage, *Water pollution control, *Water resources management, Administrative regulations, Interagency cooperation, Management planning, Urban hydrology, Wastewater management, Wastewater treatment, Water policy, Water pollution sources, Water quality control, Water quality standards.

The adverse impacts of urbanization have contributed to a decline in the water quality of some of Maryland's streams and rivers, and the Chesapeake Bay. One of the state of Maryland's initiatives in response to this was the creation of a statewide storm water management (SWM) program in 1982. This multipurpose program addresses a full range of hydrologic consequences and not just traditional runoff peak control. The Maryland Department of

the Environment administers the program and is responsible for program implementation, plan review and approval, grants administration, education and training, and inspection and enforcement. Local jurisdictions administer their own programs that must meet minimum state standards. Water quality measures to enhance pollutant removal are emphasized. Practices used for the treatment of storm water include infiltration structures, shallow marsh creation, extended detention basins, and water quality inlets. Retrofitting of existing SWM structures is done to enhance pollutant removal. Maryland's erosion and sediment control program is a key part of management efforts. Research and monitoring are conducted, and use of innovative practices is encouraged. (See also W91-03704) (Author's abstract)
W91-03726

NEW STRATEGIES IN URBAN DRAINAGE AND STORMWATER POLLUTION CONTROL IN SWITZERLAND.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 6E.
W91-03727

AESTHETIC IMPLEMENTATION OF NONPOINT SOURCE CONTROLS.
Camp, Dresser and McKee, Inc., Cincinnati, OH.
L. A. Roesner.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 213-223, 5 fig, 2 tab, 14 ref.

Descriptors: *Aesthetics, *Nonpoint pollution sources, *Water pollution control, *Water pollution sources, *Water resources management, Artificial wetland treatment, Detention reservoirs, Infiltration, Land development, Land management, Landscaping, Recreation facilities, Urban runoff, Water policy.

To many people, nonpoint source (NPS) pollution controls are unsightly, necessary evils that are required to protect our receiving waters from pollution by this source. However, such a condition need not exist if the designer will integrate these facilities into the overall landscaping design of a development. Approximately four percent of the developed land is required for NPS controls. If properly designed, these facilities can serve dual recreational/aesthetic functions, as well as provide effective NPS controls. But effective NPS pollution reduction requires that the rate at which runoff is allowed to enter and pass through the drainage system is slowed, and that as much direct runoff as possible is eliminated. This means that NPS controls should be used wherever possible to encourage on-site infiltration. Nonpoint source controls such as these can be grouped into three classes: (1) detention ponds, including both wet and dry basins; (2) infiltration devices such as basins and trenches; and (3) surface filtration devices like buffer strips, grasslined channels or swales, and wetlands. In general, the most efficient are the infiltration devices. Detention basins, particularly wet detention ponds, are second to infiltration devices in efficiency. Surface filtering is the least effective, and is generally used only in combination with one or both of the other kinds of controls. To create aesthetically pleasing NPS control devices, it is not surprising to find that functional design must go hand in hand with landscaping considerations; this is particularly true in the case of detention ponds and wetlands, where the plantings are most visible. (See also W91-03704) (Fish-PTT)
W91-03728

WETLANDS: A FUTURE NONPOINT POLLUTION CONTROL TECHNOLOGY.
Wetlands Research, Inc., Chicago, IL.
D. L. Hey.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 225-235, 1 fig, 4 tab, 6 ref.

Descriptors: *Artificial wetland treatment, *Nonpoint pollution sources, *Wastewater treatment, *Water pollution control, *Water pollution sources, *Water resources management, *Wetlands, *Wetlands treatment, Economic aspects, Environmental impact, Flood control, Habitats, Illinois, Interagency cooperation, Political aspects, Water policy, Water pollution treatment, Water quality management, Wetland restoration.

Nonpoint pollution encompasses more than just the washoff of contaminants and the dispersion of those contaminants in the receiving water body. it also involves the capacity of the terrestrial and aqueous environments to detain and process the contaminants without adverse effects. Accordingly, control technologies must encompass both washoff and effective treatment. Wetlands, serving as the transition between land and water, uniquely combine these components. The Des Plaines River Wetlands Demonstration Project in Wadsworth, Illinois, is testing the economic efficiency and political acceptability of building and managing wetlands for nonpoint pollution control. A full-scale, 450-acre research facility is being constructed with financial support from industries, foundations, private contributors, and local, state, and federal agencies. The supporters, regardless of political philosophy, recognize the need for managing our water resources more efficiently and effectively. Wetlands offer a technology for achieving this goal. The Des Plaines project offers a means for developing this technology. The objectives of this project are to: demonstrate the benefits of wetland restoration for water quality improvement, flood control, and fish and wildlife habitat enhancement; formulate and evaluate restoration and maintenance techniques; and develop alternatives to existing environmental investment strategies and regulatory programs. A significant portion of these wetlands can be replaced or restored so that they provide the desired benefits more efficiently. Replacing 10 percent of the lost wetlands would be a modest beginning. (See also W91-03704) (Author's abstract)
W91-03729

WATER QUALITY PERFORMANCE OF A DETENTION BASIN-WETLAND TREATMENT SYSTEM IN AN URBAN AREA.
Metropolitan Council, St. Paul, MN.
P. Wotzka, and G. Oberts.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 237-247, 8 fig, 3 tab, 9 ref.

Descriptors: *Detention reservoirs, *Nonpoint pollution sources, *Wastewater treatment, *Water resources management, *Wetlands, *Wetlands treatment, Climatic effects, Minnesota, Nutrient removal, Performance evaluation, Phosphorus, Precipitation, Runoff, Settleable solids, Snowmelt, Watershed management.

The McCarrons Treatment System is a surface water management facility consisting of a detention pond followed by six 'chambered' wetlands designed to improve the water quality of Lake McCarrons in Roseville, Minnesota. The system is located at the bottom of a 243 hectare urban watershed. Most of the reduction in pollutants occurs in the detention pond. Performance conclusions are based on results from 21 of the 57 rainfall events and 4 periods of snowmelt. Climatic conditions and the precipitation during the 21 months of study were not 'normal,' but rather reflective of a mild, dry period with a major rainfall event and two very wet months. The detention pond is considered to be currently performing at the best level that can be expected. Attributes thought to contribute positively to treatment levels in the pond include diffuse inflow from three separate tributaries, a low dissolved phosphorus to total phosphorus (DP:TP) ratio, and newly exposed peat soils with a high affinity for attracting TP. Changes in the design of the outlet structure could improve the effectiveness of the detention pond in treating snowmelt. The post-detention wetland system was intended to 'polish' outflows from the detention pond before the water discharged to the lake. The wetland continues the process of settling solids begun in the pond, but is less effective in removing soluble nutrients. This situation is partially related to additional inputs to the wetlands from another tributary, overland runoff, and atmospheric deposition. Even though nutrient removal in the wetland is not high, there is a net reduction so the wetland is performing as expected. (See also W91-03704) (Author's abstract)
W91-03730

NPSP ABATEMENT PROGRAM FOR THE LAGOON OF VENICE.
Padua Univ. (Italy). Ist. di Chimica Industriale.
G. Bendoricchio.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 249-260, 3 fig, 3 tab, 10 ref.

Descriptors: *Italy, *Nonpoint pollution sources, *Venice Lagoon, *Water pollution control, *Water pollution sources, *Water resources management, Artificial wetland treatment, Hydrologic models, Research priorities, Trophic level, Urban drainage, Waste load, Water policy, Water pollution treatment, Wetlands.

The Lagoon of Venice is a partially hypertrophic lagoon of the northern Adriatic Sea in Italy. The pollution of the Lagoon of Venice is a local technical and political issue but, at the same time, it is a problem of international interest due to the historical and cultural value of the city. The pollution abatement program (PAP) considers all the pollution sources responsible for potential pollutant load to the Lagoon of Venice. This global approach is needed due to the large pollutant load, of which the nonpoint sources constitute about 50% of present and future loads. The relative magnitude of the nonpoint source requires special attention. However, only $400 million will be made available for the abatement of both agricultural and urban nonpoint sources, another $200 million for diversion of rivers, and $150 million for irrigation, from the total amount of about $5 billion available for the entire PAP of the Lagoon of Venice. The evaluation of the expected benefits of such an abatement program on a complex system such as the Lagoon of Venice, will be possible only by using a general trophic model of the lagoon which has not yet been developed and validated. This is one of the joint research topics that must be developed in the near future with the experimental application of a wetlands abatement system and an evaluation of the natural assimilation abatement of nutrients that can occur during transport in the rivers. The technical analysis of the single sources developed for the PAP indicates the feasibility of some abatement activities similar to those carried out for other polluted lakes and rivers in the world. (See also W91-03704) (Fish-PTT)
W91-03731

WATER QUALITY AND THE CONSERVATION RESERVE PROGRAM: IMPLICATIONS OF TARGETING SALINE CROPLANDS.
Economic Research Service, Washington, DC.
M. P. Aillery.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 261-270, 1 fig, 23 ref.

Descriptors: *Conservation, *Cropland, *Environmental policy, *Government finance, *Nonpoint pollution sources, *Saline soils, *Water resources management, Cost-benefit analysis, Crop production, Farming, Governmental interrelations, Irrigation, Water policy.

The Conservation Reserve Program (CRP) of the 1985 Food Security Act provides an opportunity for improved water quality and higher farm prices through retirement of environmentally-sensitive

croplands. Although current enrollment is limited to highly erodible soils and stream buffers, salinity is cited as one of several criteria which may be used to determine future cropland eligibility. Extending CRP eligibility to highly saline irrigated soils has an effect on acreage enrollment, water quality, production control, and program cost. Modification of program eligibility criteria to include irrigated saline croplands will not significantly expand the national acreage pool, although local effects may be important. Potential new enrollment is limited by additional eligible acreage, county enrollment ceilings, and enrollment incentives for irrigated lands. Offsite water quality benefits attributable to reduced salt-loading may be very significant. However, enrollment of irrigated saline cropland is less cost-effective than currently eligible cropland from a commodity supply perspective. State involvement in support of a CRP salinity provision is likely to increase program effectiveness. (See also W91-03704) (Author's abstract)
W91-03732

RESULTS OF FIFTEEN YEARS OF CONTINUOUS MONITORING OF WATER QUALITY IN THE RUHR RIVER HEAVILY AFFECTED BY RESIDUAL POINT AND NONPOINT POLLUTION.
Ruhrverband, Essen (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W91-03733

BIOMANIPULATION: RETROSPECTIVE AND FUTURE DEVELOPMENT.
Kinneret Limnological Lab., Tiberias (Israel).
M. Gophen.
Hydrobiologia HYDRB8, Vol. 200/201, p 1-11, August 27, 1990. 117 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Bioremediation, *Lake restoration, *Limnology, *Water quality management, Ecosystems, Eutrophication, Fish management, Food chains, Lakes, Trophic level.

Biomanipulation (as defined by Shapiro) and top-down or consumer-controlled forces refer to the control of natural organisms to improve water quality rather than through nutrient management. A cornerstone of biomanipulation studies was established during the late fifties and early sixties when the effect of fish on water quality via zooplankton predation was shown. Biomanipulation through animals other than fish or zooplankton also has been noted. The classical limnological concept of lake trophic-dynamics goes from nutrients through phytoplankton to zooplankton and fish. Therefore, top-down forces as a tool for manipulation was seen as a pioneering approach. During the seventies, many studies of trophic cascading effects of fish through zooplankton predation on phytoplankton were carried out. The removal of macrophytes by grass carp also has been investigated and was implemented as a practical way of controlling these plants. During the eighties the concept of biomanipulation was broadened to include other aspects of the complex interactions between food-web components such as the different nutrient flux pathways. To be able to make long-term predictions for water quality improvement in lakes and reservoirs, the combined analysis of both top-down and bottom-up forces is required. (See also W91-03762) (Author's abstract)
W91-03761

BIOMANIPULATION: THE NEXT PHASE--MAKING IT STABLE.
Minnesota Univ., Minneapolis. Limnological Research Center.
J. Shapiro.
Hydrobiologia HYDRB8, Vol. 200/201, p 13-27, August 27, 1990. 2 fig, 1 tab, 80 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Bioremediation, *Fish management, *Lake restoration, *Limnology, *Water quality management, Aquatic habitats, Ecosystems, Fish establishment, Food chains, Lakes, Literature review.

Review of the literature on biomanipulation shows that fish manipulations have occurred through the following methods: piscivore catch restriction; habitat enhancement; piscivore removal; planktivore exclusion; planktivore removal by selective catch, lake emptying, fish poisons, fish disease, winterkill, and summerkill; habitat expansion or contraction; planktivore addition; and natural events. The methods can be classified as deliberate, inadvertent, or natural, all of which have successful and unsuccessful examples. However, the problem of perpetuation of successful results remains unsolved. It is proposed that this may be resolved through use of a refuge or refuges from among the following: low light intensity refuge; low temperature refuge; low dissolved oxygen refuge; physical concealment refuge; visual clutter refuge; behavior modification refuge; and predator inefficiency refuge. Perhaps through the use of such mechanisms large herbivorous zooplankters can continue to exist in lakes. (See also W91-03761) (Author's abstract)
W91-03762

ARE BLUE-GREEN ALGAE A SUITABLE FOOD FOR ZOOPLANKTON: AN OVERVIEW.
Istituto Italiano di Idrobiologia, Pallanza (Italy).
For primary bibliographic entry see Field 2H.
W91-03763

EFFECTIVENESS OF PHYTOPLANKTON CONTROL BY LARGE-BODIED AND SMALL-BODIED ZOOPLANKTON.
Warsaw Univ. (Poland). Dept. of Hydrobiology.
P. Dawidowicz.
Hydrobiologia HYDRB8, Vol. 200/201, p 43-47, August 27, 1990. 6 fig, 19 ref.

Descriptors: *Algal control, *Biocontrol, *Biomanipulation, *Lake restoration, *Limnology, *Phytoplankton, *Poland, *Water quality management, *Zooplankton, Daphnia, Food habits, Lake Ros, Lakes, Nutrients, Phosphorus, Plant growth.

Employing in situ enclosures containing inocula of lake zooplankton (mainly Daphnia galeata, D. cucullata, and Bosmina spp.) from the moderately eutrophic Lake Ros (Northern Poland) or large-bodied D. magna, several observations were made on succession of phytoplankton. Whereas D. magna could control the density of all phytoplankton size classes, the lake zooplankton could not suppress the large-sized phytoplankters or net phytoplankton. The lake zooplankton was able to control the density of small algae (< 50 micrometer), but its effect on large algae may be opposite, i.e., a promotion of net phytoplankton growth by removing small-sized algae that can out-compete net phytoplankton for limited phosphate-P resources (< 5 microgram P/L). Since efficiency of phytoplankton density control by D. magna decreased with an increase in net phytoplankton abundance, biomanipulation could not be successful without introducing or maintaining a high population of large-bodied cladoceran species before high densities of large algae would make the control of phytoplankton inefficient. (Author's abstract)
W91-03764

ANALYSIS OF PHYTOPLANKTON-ZOOPLANKTON RELATIONSHIPS IN AN OLIGOTROPHIC LAKE UNDER NATURAL AND MANIPULATED CONDITIONS.
Granada Univ. (Spain). Dept. de Biologia Animal, Ecologia y Genetica.
For primary bibliographic entry see Field 2H.
W91-03765

BIOMANIPULATION BY INTRODUCTION OF HERBIVOROUS ZOOPLANKTON: A HELPFUL SHOCK FOR EUTROPHIC LAKES.
Institut fuer Entwicklung und Forschung Dr. Vielberth K.G., Regensburg (Germany, F.R.).
J. Theiss, K. Zielinski, and H. Lang.
Hydrobiologia HYDRB8, Vol. 200/201, p 59-68, August 27, 1990. 6 fig, 31 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Eutrophic lakes, *Germany, *Lake restoration, *Limnology, *Transparency, *Water quality control, *Zooplankton, Ammonia, Bioremediation, Chlorophyll, Daphnia, Dissolved oxygen, Food habits, Gewerbepark Pond, Limnocorrals, Macrophytes, Nitrogen, Phosphorus, Turbidity, University Pond, Water quality management.

In 1988 and 1989, Daphnia magna was introduced into the Gewerbepark Pond and into the University Pond (both in Regensburg, Germany) and into a limnocorral (10 m diameter, 5 m deep) in Posfelden Reservoir. Limnological parameters were monitored in all three water bodies for 3 mo or more. The objective of the experiments was to induce a clear-water period in turbid eutrophic waters by direct manipulation of the zooplankton community. Introduction of 4 million individuals of D. magna (10 individuals/L) caused a long-lasting clear-water period in the limnocorral. While Secchi-disc transparency in the reservoir decreased from 1.3 to < 1 m during summer, transparency increased to a stable level of about 4 m in the corral. Despite very low phytoplankton biomass, D. magna was abundant. The experiment was terminated after 3 mo because of oxygen depletion in the corral. In the Gewerbepark Pond, 3.3 million individuals of D. magna (0.6 individuals/L) were introduced at the beginning of August. The daphnids soon increased 60-fold in their density, causing a persistently high water transparency and low phytoplankton biomass up to November. Ammonia concentration rose steeply, whereas that of nitrate and oxygen decreased. Subsequently in summer, concentrations of chlorophyll and organic P and N were extremely low. Instead of the phytoplankton, Elodea canadensis grew enormously and covered 12% of the pond surface. The biomanipulation experiment in University Pond failed, probably due to predation by carp. (Author's abstract)
W91-03766

ZOOPLANKTON-PHYTOPLANKTON INTERFACE IN LAKES OF CONTRASTING TROPHIC STATUS: AN EXPERIMENTAL COMPARISON.
California Univ., Davis. Div. of Environmental Studies.
For primary bibliographic entry see Field 2H.
W91-03767

WHY DO CLADOCERANS FAIL TO CONTROL ALGAL BLOOMS.
Warsaw Univ. (Poland). Dept. of Hydrobiology.
Z. M. Gliwicz.
Hydrobiologia HYDRB8, Vol. 200/201, p 83-97, August 27, 1990. 11 fig, 87 ref. Polish CPBP 10.2 Grant.

Descriptors: *Algal control, *Biomanipulation, *Bioremediation, *Eutrophication, *Lake restoration, *Limnology, *Water quality management, *Zooplankton, Algae, Cyanophyta, Daphnia, Ecosystems, Eutrophic lakes, Lake management, Phytoplankton.

Field studies show that even at high nutrient loads phytoplankton may be kept at low levels by filter-feeding zooplankton for a period of weeks (spring clear-water period in lakes) or months (low-stocked fish ponds). Laboratory experiments have shown that large-bodied Daphnia can utilize filamentous algae. In the field, this is not always the case, however. Even when protected from predation, large cladocerans often cannot grow and reproduce fast enough to prevent bloom formation. Sometimes they disappear when the bloom becomes dense, and the biomanipulation approach is no longer applicable. Recent experimental data on four differently-sized Daphnia species were used in an attempt to: (1) explain why cladocerans fail to control filamentous cyanobacteria when filament density is high and (2) determine the critical filament density at which Daphnia becomes ineffective. At this critical concentration, Daphnia growth and reproduction is halted, and no positive numerical response to growing phytoplankton standing crop should be expected from the Daphnia population. Bloom formation thus becomes irreversible. The question of how to overcome this obstacle in the biomanipulation approach may become one of the most challenging questions in

plankton ecology in the near future. (Author's abstract)
W91-03768

STRUCTURAL AND GRAZING RESPONSES OF ZOOPLANKTON COMMUNITY TO BIOMANIPULATION OF SOME DUTCH WATER BODIES.
Limnologisch Inst., Nieuwersluis (Netherlands).
R. D. Gulati.
Hydrobiologia HYDRB8, Vol. 200/201, p 99-118, August 27, 1990. 6 fig, 4 tab, 46 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Food habits, *Lake restoration, *Limnology, *Netherlands, *Zooplankton, Biomass, Bioremediation, Comparison studies, Cyanophyta, Daphnia, Ecosystems, Eutrophic lakes, Organic carbon, Performance evaluation, Seston, Water quality management.

Structure and grazing activities of crustacean zooplankton were compared in five lakes undergoing manipulation with several unmanipulated eutrophic (shallow) and mesotrophic (deep) lakes in The Netherlands. Daphnia hyalina (= D. galeata) and D. cucullata generally co-occurred in the unmanipulated lakes, but in the manipulated lakes both D. hyalina and other large-bodied daphnids, D. magna, D. pulex were the important grazers. In the biomanipulated lakes, an increase in individual crustacean size and of zooplankton mass were reflected in a decrease in seston concentration, higher Secchi-disk depth, and a marked decrease in the share of phytoplankton volume consisting of cyanobacteria. The biomass relationship between seston (150 micrometer) and zooplankton indicated a Monod type relationship, with an initial part of the curve in which the zooplankton responds linearly to the seston increase up to about 2 mg C/L, followed by a saturation of zooplankton mass (0.39 mg C/L) at 3-4 mg C/L seston, and an inhibitory effect on zooplankton mass at seston levels > 4 mg C/L. The last of these effects is related to predominance in the seston of cyanobacteria. In the biomanipulated lakes, the zooplankton grazing rates often exceeded 100% per day during the spring, and food levels generally dropped to < 0.5 mg C/L. The computed specific clearance rate (SCR) of zooplankton of 1.9 L/mg Zoopl C is well within the range of SCR values (1.7-2.2 L/mg C) from deep and mesotrophic waters, but about an order of magnitude higher than in the eutrophic lakes, with the food levels 10-fold higher. For 25% per day clearance of lake seston, between 35 and 60 individ./L are needed in the biomanipulated lakes versus 1200-1300 individ./L in the eutrophic lakes. Similarly, about 10-15 more crustacean grazers are required to eliminate the daily primary production the eutrophic lakes than in the biomanipulated lakes. The biomass values of zooplankton needed to clear the daily primary production in the eutrophic waters were 0.1-0.2 mg C/L in the biomanipulated lakes, but about 0.45 mg C/L in the unmanipulated eutrophic waters. Only if water was kept clear by zooplankton was the seston budget balanced (primary production vs removal by grazing). Usually, the input exceeded the removal by zooplankton. Thus, estimated seston loss could be attributed to sedimentation and mineralization. (Author's abstract)
W91-03769

BIOMANIPULATION AND FOOD-WEB DYNAMICS: THE IMPORTANCE OF SEASONAL STABILITY.
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 2H.
W91-03770

IMPACT OF WHITEFISH ON AN ENCLOSURE ECOSYSTEM IN A SHALLOW EUTROPHIC LAKE: SELECTIVE FEEDING OF FISH AND PREDATION EFFECTS ON ZOOPLANKTON COMMUNITIES.
National Inst. for Environmental Studies, Tsukuba (Japan). Environmental Biology Div.
For primary bibliographic entry see Field 2H.
W91-03771

IMPACT OF WHITEFISH ON AN ENCLOSURE ECOSYSTEM IN A SHALLOW EUTROPHIC LAKE: CHANGES IN NUTRIENT CONCENTRATIONS, PHYTOPLANKTON AND ZOOBENTHOS.
National Inst. for Environmental Studies, Tsukuba (Japan). Environmental Biology Div.
For primary bibliographic entry see Field 2H.
W91-03772

FADING RECOVERY: THE ROLE OF ROACH (RUTILUS RUTILUS L.) IN MAINTAINING HIGH PHYTOPLANKTON PRODUCTIVITY AND BIOMASS IN LAKE VESIJARVI, SOUTHERN FINLAND.
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
J. Horppila, and T. Kairesalo.
Hydrobiologia HYDRB8, Vol. 200/201, p 153-165, August 27, 1990. 5 fig, 1 tab, 20 ref.

Descriptors: *Algal control, *Biocontrol, *Finland, *Lake management, *Lake restoration, *Limnology, *Water quality control, Biomass, Bioturbation, Cyanophyta, Enclosures, Eutrophic lakes, Eutrophication, Fish, Lake Vesijarvi, Mesocosms, Phytoplankton, Primary productivity, Roach, Sediment recycling, Wastewater pollution.

For 60 yr, Lake Vesijarvi, especially the Enonselka basin (2600 ha), received sewage water discharge from the City of Lahti. In 1976 the municipal sewage loading was diverted from the lake. Initially, the recovery of the lake proceeded well but after some years summer blooms of blue-green algae (Aphanizomenon, Microcystis) increased again. High biomass of roach (Rutilus rutilus L.) was considered to play an important role in maintaining high algal productivity and biomass in the lake water. Field experiments in mesocosms (22-24 cu m) with different densities of roach suggested that fish biomass should be less than 30 g/sq m, or 300 kg/ha, to ensure a significant reduction in the current productivity and biomass of phytoplankton. Bioturbation of sediments and recycling of nutrients, rather than zooplanktivory, seemed to be the main factors linking roach to water quality in the mesocosms. The results suggest that the current (estimated) biomass of fish in Lake Vesijarvi (500 kg/ha), composed mainly of roach and smelt) is one of the key factors maintaining high algal productivity in the lake. The current results probably are best applied to littoral areas, where densities of roach are greatest, rather than to the entire lake. (Rochester-PTT)
W91-03773

BOTTOM-UP EFFECTS OF BREAM (ABRAMIS BRAMA L.) IN LAKE BALATON.
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
For primary bibliographic entry see Field 2H.
W91-03774

APPLICABILITY OF PLANKTONIC BIOMANIPULATION FOR MANAGING EUTROPHICATION IN THE SUBTROPICS.
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
T. L. Crisman, and J. R. Beaver.
Hydrobiologia HYDRB8, Vol. 200/201, p 177-185, August 27, 1990. 6 fig, 1 tab, 32 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Florida, *Lake management, *Lake restoration, *Plankton, *Subtropic zone, *Water quality control, Algae, Biomass, Bioremediation, Crustaceans, Ecosystems, Eutrophic lakes, Fish, Fish management, Life history studies.

Although large-bodied cladocerans such as Daphnia can reduce algal biomass significantly in temperate lakes if freed from fish predation, the applicability of such biomanipulation techniques for eutrophication management in the subtropics and tropics has been examined only recently. Subtropical cladoceran assemblages differ from those of temperate lakes by their low species richness, early summer gametogenesis, and greatly reduced body size. Eutrophic Florida lakes are dominated by pump-feeding fish rather than by size-selective planktivores as in temperate lakes. Cladocerans in Florida lakes can increase in abundance significantly if freed from fish but fail to have an impact on algal biomass or composition. The greatest potential for using biomanipulation to manage phytoplankton-dominated lakes in the subtropics and tropics lies with phytophagous fish. Future research should concentrate on defining the effect of individual fish taxa on phytoplankton composition and community structure, nutrient cycling, and planktonic productivity before embarking on whole-lake manipulation projects. (Author's abstract)
W91-03775

CONDITIONS FOR EFFECTIVE BIOMANIPULATION: CONCLUSIONS DERIVED FROM WHOLE-LAKE EXPERIMENTS IN EUROPE.
Technische Univ., Dresden (German D.R.). Sektion Wasserwesen.
J. Benndorf.
Hydrobiologia HYDRB8, Vol. 200/201, p 187-203, August 27, 1990. 4 fig, 3 tab, 56 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Food chains, *Lake management, *Lake restoration, *Limnology, *Water quality control, Fish, Food habits, Light, Nutrients, Performance evaluation, Phosphorus, Refugia.

Since indirect effects, feedback mechanisms, and time lag play an important role in top-down manipulated food webs, conclusions regarding the reliability of biomanipulation as a management tool should be derived only from whole-lake studies, the results of which were followed for at least 3-5 yr. There are only a few experiments of that type, from which the following conclusions can be draw: (1) food web manipulation should be combined with resource limitation measures (nutrients or light) if a 'biomanipulation-efficiency threshold of the phosphorus loading' is exceeded; (2) the critical biomass of undesirable fish shows a very wide range of variation (20-1000 kg/ha) and depends on several factors, such as species and age of fish, total food assemblage, and refugia; (3) the maximum possible stability of food web manipulation is probably achieved at a biomass of undesirable fish a little below the critical biomass rather than by extermination of these fish; (4) high piscivore diversity increases stability and reliability of food web manipulations; and (5) various techniques of food web manipulation should be combined, except poisoning the entire fish community. (Author's abstract)
W91-03776

FISH MANIPULATION AS A LAKE RESTORATION TOOL IN SHALLOW, EUTROPHIC TEMPERATE LAKES: 1. CROSS-ANALYSIS OF THREE DANISH CASE-STUDIES.
National Environmental Research Inst., Silkeborg (Denmark). Div. of Freshwater Ecology.
E. Jeppesen, M. Sondergaard, E. Mortensen, P. Kristensen, and B. Riemann.
Hydrobiologia HYDRB8, Vol. 200/201, p 205-218, August 27, 1990. 4 fig, 3 tab, 65 ref.

Descriptors: *Biomanipulation, *Bioremediation, *Eutrophic lakes, *Fish management, *Lake restoration, *Limnology, Algal blooms, Biomass, Case studies, Chlorophyta, Cyanophyta, Denmark, Diatoms, Ecosystems, Fish, Frederiksborg Castle Lake, Lake Sobygard, Lake Vaeng, Nitrogen, Nutrients, Phosphorus.

The use of fish manipulation as a tool for lake restoration in eutrophic lakes has been investigated since 1986 in three shallow, eutrophic Danish lakes. The lakes differ with respect to nutrient loading and nutrient levels (130-1000 microgram P/L, 1-6 mg N/L). A 50% removal of planktivorous fish in the less eutrophic, cyanobacteria-diatom-dominated Lake Vaeng caused marked changes in lower trophic levels, P concentration, and transparency. Only minor changes occurred after a 78% removal of planktivorous fish in eutrophic, cyanobacteria-dominated Frederiksborg Castle Lake. In the hypertrophic, green algae-

dominated Lake Sobygard a low recruitment of all fish species and a 16% removal of fish biomass created substantial changes in trophic structure, but no decrease in P concentration. The different response pattern is interpreted as: (1) a difference in density and persistence of bloom-forming cyanobacteria caused by between-lake variations in nutrient levels and probably mixing and flushing rates; (2) a difference in specific loss rates through sedimentation of the algal community prevailing after the fish manipulation; (3) a decreased impact of planktivorous fish with increasing mean depth; and (4) a lake-specific difference in ability to create a self-increasing reduction in the P level in the lake water. This in turn seems related to the P loading. (See also W91-03778) (Author's abstract)
W91-03777

FISH MANIPULATION AS A LAKE RESTORATION TOOL IN SHALLOW, EUTROPHIC, TEMPERATE LAKES 2: THRESHOLD LEVELS, LONG-TERM STABILITY AND CONCLUSIONS.
National Environmental Research Inst., Silkeborg (Denmark). Div. of Freshwater Ecology.
E. Jeppesen, J. P. Jensen, P. Kristensen, M. Sondergaard, and E. Mortensen.
Hydrobiologia HYDRB8, Vol. 200/201, p 219-227, August 27, 1990. 5 fig, 35 ref.

Descriptors: *Algal control, *Biomanipulation, *Bioremediation, *Fish management, *Lake restoration, *Limnology, *Water quality control, Cyanophyta, Denmark, Eutrophic lakes, Fish, Phosphorus, Phytoplankton, Transparency.

Empirical studies on relationships between concentration of total P in lake water and the occurrence of phytoplankton, submerged macrophytes, and fish in Danish lakes were combined with results from three whole-lake fish manipulation experiments. After removal of less than 80% of the planktivorous fish stock, a short-term trophic cascade was obtained in the nutrient regimes, where large cyanobacteria were not strongly dominant and persistent. In shallow Danish lakes, cyanobacteria dominated the phytoplankton most often in the P-range between 200 and 1000 microgram P/L. Long-term effects are suggested to be closely related to the ability of the lake to establish a permanent and wide distribution of submerged macrophytes and to create self-perpetuating increases in the ratio of piscivorous to planktivorous fish. The maximum depth at which submerged macrophytes were absent in lake > 10 ha and with P levels above 250-300 microgram P/L, but still abundant in some lakes < 3 ha at 650 microgram P/L. These results support the alternative stable state hypothesis (clear or turbid water stages). Planktivorous fish > 10 cm numerically contributed more than 80% of the total planktivorous and piscivorous fish (> 10 cm) in the pelagic zone of lakes with concentrations of P above 100 microgram/L. Below this threshold level the proportion of planktivores decreased markedly to about 50% at 22 microgram P/L. The extent of the shift in depth colonization of submerged macrophytes and fish stock composition in three whole-lake fish manipulations follows closely the predictions from the relationships derived from the empirical study. It is concluded that a long-term effect of a reduction in the density of planktivorous fish can be expected only when the external P loading is reduced to below 0.5-2.0 g per sq m/yr. This loading is equivalent to an in-lake summer concentration below 80-150 microgram P/L. Fish manipulation as a restoration technique seems most efficient in shallow lakes. (See also W91-03777) (Rochester-PTT)
W91-03778

PHYTOPLANKTON BIOMASS REDUCTION AFTER PLANKTIVOROUS FISH REDUCTION IN A SHALLOW, EUTROPHIC LAKE: A COMBINED EFFECT OF REDUCED INTERNAL P-LOADING AND INCREASED ZOOPLANKTON GRAZING.
National Environmental Research Inst., Silkeborg (Denmark). Div. of Freshwater Ecology.
M. Sondergaard, E. Jeppesen, E. Mortensen, E. Dall, and P. Kristensen.
Hydrobiologia HYDRB8, Vol. 200/201, p 229-240, August 27, 1990. 7 fig, 2 tab, 43 ref.

Descriptors: *Biomanipulation, *Bioremediation, *Eutrophic lakes, *Lake restoration, *Limnology, *Phosphorus, *Water quality control, Biomass, Bream, Denmark, Ecosystems, Food chains, Lake Vaeng, Light, Macrophytes, Phytoplankton, Roach, Submerged plants, Zooplankton.

No recovery was recorded in the shallow and eutrophic Lake Vaeng, Denmark, after a sewage diversion in 1981, due to an internal P loading and a dominance of planktivorous fish. To improve water quality by biomanipulation, a total of 2.5 tons of bream (Abramis brama) and roach (Rutilus rutilus) was removed during 1986 and the spring of 1987. The planktivorous/benthivorous fish biomass thereby was reduced by approximately 50%, from 30 to 16 g ww/sq m. After the reduction, the biological structure of the lake changed markedly. The zooplankton changed from a dominance by rotifers to larger cladocerans. Zooplankton mean biomass increased from 0.4 mg dw/L in 1986 to 2.7 mg dw/L in 1987 and 1.3 mg dw/L in 1988. Phytoplankton biomass decreased from a mean summer level of 25 cu mm/L in 1986 to 12 cu mm/L in 1987 and to 7 cu mm/L in 1988. After the fish removal, the internal P loading was reduced markedly. This reduction is considered primarily to be due to reduced sedimentation, and by the increased micro-benthic primary production and P uptake. Submerged macrophytes, mainly Potamogeton crispus and Elodea canadensis, increased in abundance due to improved light climate at the lake bottom. (Author's abstract)
W91-03779

ECOLOGICAL CONSEQUENCES OF A MANUAL REDUCTION OF ROACH AND BREAM IN A EUTROPHIC, TEMPERATE LAKE.
Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.
B. Riemann, K. Christoffersen, H. J. Jensen, J. P. Muller, and C. Lindegaard.
Hydrobiologia HYDRB8, Vol. 200/201, p 241-250, August 27, 1990. 6 fig, 3 tab, 40 ref. Danish Natural Science Research Council Grant 11-6934.

Descriptors: *Biocontrol, *Biomanipulation, *Bioremediation, *Ecosystems, *Fish management, *Food chains, *Water quality control, Bream, Denmark, Eutrophic lakes, Lake Frederiksborg Slotsso, Lake restoration, Nutrients, Oxygen, Perch, Phytoplankton, Roach, Water quality management.

A biomanipulation experiment was carried out in the eutrophic Lake Frederiksborg Slotsso (Denmark). During 1987 and 1988, densities of roach (Rutilus rutilus) and bream (Abramis brama) were reduced and large-sized perch (Perca fluviatilis) were added. Nutrients, oxygen, phytoplankton, zooplankton, fish, and zoobenthos were measured for 2 yr after the manipulation and compared with results obtained 2 yr before the manipulation. A total amount of 6524 kg wet weight of roach and bream was removed. Roach and bream constituted 45% of the total fish biomass after the reduction, compared with 78% before the manipulation. Recruitment of roach decreased, and mortality rates of young-of-the-year perch were lower after the fish reduction. After the manipulation, decreases in phytoplankton biomass coincided with increases in zooplankton biomass during spring and autumn periods, but the mid-summer level of the biomass of cyanobacteria did not change. Inorganic nutrients generally increased, but no significant changes were found, either in the oxygen budget or in the community structure or quantitative distribution of zoobenthos after the fish manipulation. Although the effects of the fish manipulations were not as pronounced as those found in lakes with lower nutrient regimes, the results indicate positive changes in the water quality. Nevertheless, it is probably necessary to continue a fish reduction program to maintain or further improve the water quality. (Author's abstract)
W91-03780

PREDICTABILITY AND POSSIBLE MECHANISMS OF PLANKTON RESPONSE TO REDUCTION OF PLANKTIVOROUS FISH.
Oslo Univ. (Norway). Dept. of Limnology.
A. Lyche, B. A. Faafeng, and A. Brabrand.
Hydrobiologia HYDRB8, Vol. 200/201, p 251-261, August 27, 1990. 2 fig, 1 tab, 35 ref.

Descriptors: *Algal control, *Biocontrol, *Biomanipulation, *Bioremediation, *Food chains, *Lake restoration, *Plankton, *Predation, *Water quality control, Carbon, Carbon-phosphorus ratio, Cyanophyta, Denmark, Fish, Gjersjoen, Helgetjern, Phosphorus, Phytoplankton, Tissue analysis, Zooplankton.

The predictability of plankton response to reductions of planktivorous fish was investigated by comparing the plankton community in three biomanipulated lakes and 10 unmanipulated lakes differing in intensity of fish predation. Data collected on total P, phytoplankton, and zooplankton biomass and share of cyanobacteria and large grazers, as well as specific growth rate of phytoplankton, were further used to test some of the proposed underlying response mechanisms. In the biomanipulated lakes, the algal biomass and share of cyanobacteria decreased, specific growth rate of phytoplankton increased, and zooplankton biomass and share of large grazers increased or remained unchanged. This pattern was largely reflected in the differences in food-chain structure between the unmanipulated lakes with high versus those with low fish predation. The qualitative response to planktivorous fish reduction thus seems largely predictable. The biomanipulated lakes differed, however, in magnitude of response: the smallest, hypertrophic, rotenone-treated lake (Helgetjern) showed the most dramatic response, whereas the large, deep mesotrophic lake (Gjersjoen), which was stocked with piscivorous fish, showed more moderate response, probably approaching a new steady state. These differences in response magnitude may be related to different perturbation intensity (rotenone treatment versus stocking with piscivores), food-chain complexity, and trophic state. Both decreased P concentration and increased zooplankton grazing probably are important mechanisms underlying phytoplankton response to biomanipulation in many lakes. The results provide tentative support to the hypothesis that under conditions of P limitation, increased zooplankton grazing can decrease algal biomass via two separate mechanisms: reduction of the P pool in the phytoplankton, and reduction of the C:P ratio within the phytoplankton cells. (Author's abstract)
W91-03781

OLIGOTROPHICATION AS A RESULT OF PLANKTIVOROUS FISH REMOVAL WITH ROTENONE IN THE SMALL, EUTROPHIC, LAKE MOSVATN, NORWAY.
Rogalandsforskning, Stavanger (Norway). Aquaculture and Water Research Group.
S. Sanni, and S. B. Waervagen.
Hydrobiologia HYDRB8, Vol. 200/201, p 263-274, August 27, 1990. 4 fig, 1 tab, 46 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Eutrophic lakes, *Fish management, *Lake restoration, *Limnology, *Oligotrophic lakes, *Water quality control, Algal control, Biomass, Bioremediation, Chlorophyll a, Daphnia, Lake Mosvatn, Lake management, Nitrogen, Norway, Phosphorus, Rotenone, Rotifers, Transparency, Whitefish, Zooplankton.

In September 1987 the shallow, eutrophic, Lake Mosvatn (Norway) was treated with rotenone to eliminate planktivorous fish (mainly whitefish, Coregonus lavaretus L.), and the effects were studied. The first summer after treatment the zooplankton community changed markedly from rotifer dominance and few grazers, to a community with few rotifers and many grazers. Accordingly there was a five-fold increase in the biomass of Daphnia galeata. Adult females of D. galeata approximately doubled their weight. The decrease in rotifer biomass probably was mainly due to a loss of food by competition with the daphnids. The phytoplankton community also was markedly affected. Prior to

treatment Secchi depth was 1.7 m and chlorophyll-a was 23 microgram/L in summer. After treatment there was an increase in the proportion of small and gelatinous algae and the mean chlorophyll concentration fell to 7 microgram chlorophyll a/L. Secchi depth increased to > 2.3 m (bottom-sight most of the season). After the treatment there also were fewer cyanobacterial blooms. This seems to be related to oligotrophication caused indirectly by increased grazing by the zooplankton. Total nutrient concentrations were affected. Prior to treatment the mean summer concentration of total phosphate was 44 microgram P/L. This decreased to 29 microgram P/L in the first summer and 23 microgram P/L the second summer after the treatment. Total N decreased from 0.68 mg N/L before the treatment to 0.32 mg N/L the first summer after treatment. The phosphate loading was not reduced, hence it can be concluded that the fish removal caused the more oligotrophic conditions. (Author's abstract)
W91-03782

WHOLE-LAKE FOOD-WEB MANIPULATION AS A MEANS TO STUDY COMMUNITY INTERACTIONS IN A SMALL ECOSYSTEM.
Water Board of Utrecht (Netherlands).
For primary bibliographic entry see Field 2H.
W91-03783

FIRST ATTEMPT TO APPLY WHOLE-LAKE FOOD-WEB MANIPULATION ON A LARGE SCALE IN THE NETHERLANDS.
Water Board of Utrecht (Netherlands).
E. van Donk, M. P. Grimm, R. D. Gulati, P. G. M. Heuts, and W. A. de Kloet.
Hydrobiologia HYDRB8, Vol. 200/201, p 291-301, August 27, 1990. 3 fig, 6 tab, 34 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Food chains, *Lake restoration, *Limnology, *Netherlands, *Water quality control, Biomass, Cyanophyta, Daphnia, Eutrophic lakes, Fish management, Lake Breukeleveen, Light, Loosdrecht Lakes, Macrophytes, Phosphorus, Pike, Submerged plants, Transparency, Turbidity, Zooplankton.

Lake Breukeleveen (180 ha, mean depth 1.45 m), a compartment of the eutrophic Loosdrecht Lakes system (The Netherlands), was selected to study the effects of whole-lake food web manipulation on a large scale. In Lake Loosdrecht (dominated by filamentous cyanobacteria), water management measures taken from 1970-1984 (sewerage systems, dephosphorization) have reduced the external P load from 1.2 g/sq m/yr to 0.35 g/sq m/yr. The water transparency (Secchi depth about 30 cm) has not improved. The aim of the food web manipulation in Lake Breukeleveen was not only to improve the light climate of the lake, but to study if the successful effects observed in lakes of a few ha in size could be upscaled. In March 1989 the standing crop of planktivorous and benthivorous fish populations was reduced by intensive fishery, from about 150 kg/ha to about 57 kg/ha. The lake was made inaccessible to fish migrating from other lakes and it was stocked with large-sized daphnids and 0+ pike. However, water transparency did not increase in the following summer and autumn 1989, which is in contrast to the great improvement in light conditions observed elsewhere in smaller lakes. The main explanations for the negative outcome in Lake Breukeleveen are: (1) the rapid increase of the planktivorous fish biomass and carnivorous cladocerans, predating on the zooplankton community; (2) suppression of the large daphnids by the high concentrations of filamentous cyanobacteria; and (3) high turbidity of the lake due to resuspension of bottom material induced by wind, unlike in smaller lakes, and consequently the inability of submerged macrophytes to develop and stabilize the system. (Author's abstract)
W91-03784

IS REDUCTION OF THE BENTHIVOROUS FISH AN IMPORTANT CAUSE OF HIGH TRANSPARENCY FOLLOWING BIOMANIPULATION IN SHALLOW LAKES.
Rijksinstituut voor Zuivering van Afvalwater, Leylstad (Netherlands).
For primary bibliographic entry see Field 2H.
W91-03785

EARLY RESPONSES OF PLANKTON AND TURBIDITY TO BIOMANIPULATION IN A SHALLOW WATER PRAIRIE LAKE.
North Dakota State Univ., Fargo. Dept. of Zoology.
M. A. Hanson, and M. G. Butler.
Hydrobiologia HYDRB8, Vol. 200/201, p 317-327, August 27, 1990. 6 fig, 1 tab, 37 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Fish management, *Lake restoration, *Limnology, *Minnesota, *Transparency, Bosmina, Chydorus, Crustaceans, Daphnia, Diatoms, Eutrophic lakes, Food chains, Lake Christina, Lake management, Macrophytes, Phosphorus, Seasonal distribution, Submerged plants, Turbidity, Zooplankton.

The effect of fish removal was evaluated in the shallow, eutrophic Lake Christina, Minnesota. Fish were removed in October. By late May of the following year, the cladoceran community had shifted from small-bodied Bosmina and Chydorous (less than 100/L) to larger Daphnia (over 100/L). During the periods of peak daphnid abundance (late May-June), chlorophyll-a concentrations and edible diatoms were reduced and water transparency improved dramatically. Total P was not lowered significantly during this period. Although this clear-water phase was short-lived (May, June, and early July), it corresponded to the critical period of plant growth and permitted dramatic increases in submerged macrophytes. (Author's abstract)
W91-03786

EFFECTS OF PLANKTIVOROUS FISH MASS MORTALITY ON THE PLANKTON COMMUNITY OF LAKE MENDOTA, WISCONSIN: IMPLICATIONS FOR BIOMANIPULATION.
Wisconsin Univ.-Madison. Center for Limnology.
For primary bibliographic entry see Field 2H.
W91-03787

EFFECTS OF PLANKTIVORE ABUNDANCE ON CHLOROPHYLL-A AND SECCHI DEPTH.
York Univ., North York (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W91-03788

THREE YEARS OF EXPERIENCE IN BIOMANIPULATING A SMALL EUTROPHIC LAKE: LAGO DI CANDIA (NORTHERN ITALY).
Istituto Italiano di Idrobiologia, Pallanza (Italy).
G. Giussani, R. de Bernardi, and T. Ruffoni.
Hydrobiologia HYDRB8, Vol. 200/201, p 357-366, August 27, 1990. 6 fig, 1 tab, 28 ref. EEC Grant CEE-CNR-EV4V-0129-I.

Descriptors: *Biocontrol, *Biomanipulation, *Bioremediation, *Eutrophic lakes, *Italy, *Lake restoration, *Limnology, *Water quality control, Bass, Biomass, Lago di Candia, Nonpoint pollution sources, Phytoplankton, Pike, Precipitation, Rudd, Runoff, Transparency, Water pollution sources.

Since the diversion of the municipal sewage of the small town of Candia (northern Italy), runoff and precipitation have been the sole contributors of nutrients to Lago di Candia. The fish population is characterized mainly by rudd (Scardinius erythrophthalmus) overstocking and by a low density of large-mouth bass (Micropterus salmoides) and pike (Esox lucius). During 1986 about 12 tons of rudd (1-2 yr old) were removed from the lake. Considering 1986 as a 'control year,' average Secchi disc transparency improved from 2.3 m in 1986 to 3.3 m in 1988. Phytoplankton biovolume decreased from 114 to 58 cu mm/L, but zooplankton biovolume increased from 8 to 11.5 cu mm/L. The results achieved show that a gradual biomanipulation treatment can have a satisfactory outcome, and it has the advantage of not producing catastrophic situations either in the biotic or in the abiotic compartments of the lake. (See also W91-03795) (Author's abstract)
W91-03790

ENGINEERING AND BIOLOGICAL APPROACHES TO THE RESTORATION FROM EUTROPHICATION OF SHALLOW LAKES IN WHICH AQUATIC PLANT COMMUNITIES ARE IMPORTANT COMPONENTS.
Liverpool Univ. (England). Dept. of Environmental and Evolutionary Biology.
B. Moss.
Hydrobiologia HYDRB8, Vol. 200/201, p 367-377, August 27, 1990. 4 fig, 59 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Bioremediation, *Eutrophic lakes, *Lake restoration, *Limnology, *Water quality control, Aquatic plants, Crustaceans, Ecosystems, England, Fish, Food chains, Norfolk Broads, Nutrients, Refuges, Zooplankton.

Engineering approaches to lake restoration (nutrient removal, sediment pumping, hypolimnion oxygenation, alum treatments) may be most appropriate to deep lakes where the aim of restoration from eutrophication is simply to reduce the production and crop of one component, the phytoplankton. These approaches do not always give the desired results because the nutrient loading may be reduced only to a limited extent. There are additional problems in shallow lakes where change of state between community dominance (aquatic plants versus plankton) is wanted. Each community has powerful buffering mechanisms and biomanipulation may be essential to switch one state to another even with considerable nutrient reduction. For the phytoplankton-dominated community the buffers include the advantages of early growth, lower diffusion pathways for CO2, overhead shading, and an absence of large cladoceran grazers. Open-water shallow environments provide no refuges against predation for the large Cladocera, which are both the most efficient grazers and the most favored prey for fish. Restoration of aquatic plants may require provision of refuges for grazers. There are two types of refuges: open and closed. Open refuges resemble the architecture of a plant bed, but without a barrier to fish. Closed refuges (cages) provide a barrier to fish, but not to small invertebrates. Closed refuges seem likely to be much more successful in restoration of the Norfolk Broads (England). (See also W91-03792) (Rochester-PTT)
W91-03791

POTENTIAL OF ARTIFICIAL REFUGIA FOR MAINTAINING A COMMUNITY OF LARGE-BODIED CLADOCERA AGAINST FISH PREDATION IN A SHALLOW EUTROPHIC LAKE.
University of East Anglia, Norwich (England). School of Environmental Sciences.
K. Irvine, B. Moss, and J. Stansfield.
Hydrobiologia HYDRB8, Vol. 200/201, p 379-389, August 27, 1990. 5 fig, 14 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Bioremediation, *Eutrophic lakes, *Lake restoration, *Limnology, *Refuges, Crustaceans, Daphnia, Ecosystems, England, Fish, Food chains, Hoveton Great Broad, Norfolk Broads, Shallow water, Zooplankton.

The Norfolk Broads are a series of shallow lakes that are highly eutrophic and typified by dense populations of phytoplankton and an absence of submerged aquatic plants. The zooplankton community is subject to intense predation pressure by young fish and is dominated by small-bodied organisms, which have a low potential for reducing phytoplankton populations through grazing. Various designs and densities of artificial refugia for zooplankton against fish predation were established in Hoveton Great Broad in order to enhance populations of large-bodied Cladocera. Initially some of the refuges contained higher densities and larger individuals of Daphnia and Ceriodaphnia than the surrounding open water. However, towards the end of the first season and throughout the subsequent 2 yr, population densities and size structure were similar both within and outside the refuges, although there was still evidence of enhanced body-size of Daphnia within the refuges

compared with the open water. The provision of habitat structures designed as refugia from fish predation did not enhance large-bodied cladoceran populations enough to promote this restoration strategy as feasible for eutrophic and shallow lakes. (See also W91-03791) (Author's abstract)
W91-03792

CAN MACROPHYTES BE USEFUL IN BIOMANIPULATION OF LAKES: THE LAKE ZWEMLUST EXAMPLE.
Warsaw Univ. (Poland). Dept. of Hydrobiology.
T. Ozimek, R. D. Gulati, and E. van Donk.
Hydrobiologia HYDRB8, Vol. 200/201, p 399-407, August 27, 1990. 7 fig, 3 tab, 36 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Lake restoration, *Limnology, *Macrophytes, *Netherlands, *Submerged plants, *Transparency, *Water quality control, Chara, Chlorophyta, Elodea, Lake Zwemlust, Limiting nutrients, Nitrogen, Phytoplankton.

Lake Zwemlust (1.5 ha, mean depth 1.5 m) has been the object of an extensive limnological study since its biomanipulation involving planktivorous fish (bream) in March 1987 and emptying of the lake. In the summer of 1987, the Secchi depth increased to the lake bottom (2.5 m), compared with about 30 cm in previous summers. The reaction of submerged macrophytes to improving underwater light climate was rapid. In summer 1987, besides the introduced Chara globularis, 5 species of submerged macrophytes occurred and colonized 10% of the lake area. In 1988 and 1989, new species did not appear, but the area colonized by macrophytes increased by 7 and 10 times, respectively. Elodea nuttallii was dominant among the macrophytes and Mougeotia among the filamentous green algae. Their abundance contributed to transient N-limitation of phytoplankton causing a persistent clear water phase in 1988 and 1989, unlike in 1987 when zooplankton grazing contributed chiefly to the water clarity. Laboratory bioassays on macrophytes confirmed nitrogen limitation. (Author's abstract)
W91-03794

BIOMANIPULATION OF LAGO DI CANDIA (NORTHERN ITALY): A THREE-YEAR EXPERIENCE OF AQUATIC MACROPHYTE MANAGEMENT.
Istituto Italiano di Idrobiologia, Pallanza (Italy).
G. Galanti, P. Guilizzonni, and V. Libera.
Hydrobiologia HYDRB8, Vol. 200/201, p 409-417, August 27, 1990. 3 fig, 1 tab, 23 ref. EEC Environmental Research Program Contract CEE-CNR-EV4V-0120-1.

Descriptors: *Aquatic plants, *Biocontrol, *Biomanipulation, *Bioremediation, *Eutrophic lakes, *Lake restoration, *Limnology, *Water pollution control, Biomass, Food chains, Italy, Lago di Candia, Nitrogen, Organic matter, Oxygen, Phosphorus removal, Phytoplankton, Rudd, Transparency, Water chestnut, Zooplankton.

A long-term experimental aquatic plant management program has been in progress since 1985 in the eutrophic Lago di Candia (northern Italy). In 1986, 7.7 ha of water chestnut (Trapa natans L.) were harvested; 8.2 ha were harvested in 1988 and 11.0 ha in 1988, removing 334, 290, and 418 tons, respectively, of fresh plant material from the lake. This annual harvesting of about 50% of the total water chestnut cover resulted in the removal from the lake of about 70 kg/yr of P, a significant portion of the annual external loading, which derives mainly from runoff and precipitation. In addition, up to 38 tons/yr of organic matter and 1 ton/yr of N were removed. First results of the effect of harvesting on Secchi-disc transparency, oxygen, total P, phytoplankton, and zooplankton are reported. The reduction of zooplanktivorous fish increased the biovolume of the zooplankton community by about 40%. Consequently, the phytoplankton biomass decreased by 50%, whereas the Secchi-disc transparency during the critical summer period (July-October) increased by 30%. These results can be ascribed both to the removal of 12 tons of rudd (Scardinius erythrophthalmus) and to the increased intensity of predation on zooplanktivorous fish as a consequence of the removal of Trapa. No significant changes in oxygen concentration were observed, although comparing the current situation with data of 1979 and 1982, when markedly anoxic conditions and the presence of H2S were observed, shows the present situation to be a considerable improvement. No other macrophyte species became abundant after harvesting before Trapa natans took over again each year. In only a few areas did Ceratophyllum demersum increase in density as a result of dispersion of fragments derived from the harvesting operation. No short-term detrimental effects such as algal blooms or nutrient recycling were observed after the macrophyte harvesting. Biomanipulation of aquatic plants in Lago di Candia appears to be valuable in controlling eutrophication. (See also W91-03790) (Rochester-PTT)
W91-03795

IMPACT OF MECHANICAL DEWEEDING ON DAL LAKE ECOSYSTEM.
Kashmir Univ., Srinagar (India). Centre of Research for Development.
D. P. Zutshi, and A. Ticku.
Hydrobiologia HYDRB8, Vol. 200/201, p 419-426, August 27, 1990. 2 fig, 4 tab, 13 ref.

Descriptors: *Aquatic plants, *Aquatic weed control, *Biomanipulation, *Eutrophic lakes, *Lake restoration, *Limnology, *Water quality control, Bioremediation, Chlorophyta, Conductivity, Dal Lake, Diatoms, Fish, India, Kashmir, Macrophytes, Nitrogen, Oxygen, Phosphorus, Recreation, Rotifers, Tourism.

The accelerated nutrient enrichment of Dal Lake, Kashmir, has augmented the production of aquatic vegetation to the point where many recreational activities have been severely impaired. Mechanical deweeding was introduced in the lake in 1986 as a way of providing relief from nuisance conditions. The effects of large-scale vegetation removal were assessed in relation to water quality, plankton population, macrophytes, and fish. Electrical conductivity, dissolved oxygen, total P concentration, and nitrate-N concentration changed significantly immediately after deweeding. Phytoplankton species that increased after deweeding included: Amphora ovalis, Cymbella cistula, and Cosmarium sp.; the rotifers Anuraeoposis fissa, Brachionus calcyciflorus, and Monostyla bulla also increased. No visible improvements in the Dal Lake environment have been observed although mechanical harvesting has been in operation for the last three years. This is mainly because harvesting operations are not being carried out on a definite schedule. Selective deweeding should occur during the height of the tourist season. The possibility of introducing biological control measures should be assessed. (Rochester-PTT)
W91-03796

PROPOSALS FOR MACROPHYTE RESTORATION IN EUTROPHIC COASTAL LAGOONS.
Barcelona Univ. (Spain). Dept. de Ecologia.
F. A. Comin, M. Menendez, and J. R. Lucena.
Hydrobiologia HYDRB8, Vol. 200/201, p 427-436, August 27, 1990. 6 fig, 8 tab, 35 ref. CICYT-Spain PAC84-16-C02-02 and EEC Contract EV4V-0132-E, TT.

Descriptors: *Aquatic plants, *Biomanipulation, *Coastal areas, *Eutrophic lakes, *Lagoons, *Lake restoration, *Macrophytes, Agricultural runoff, Encanizada Lagoon, Light, Mediterranean Sea, Nonpoint pollution sources, Particulate matter, Phytoplankton, Potamogeton, Rice, Salinity, Spain, Tancada Lagoon, Turbidity, Water pollution sources, Widgeongrass.

Based on the comparison of environmental requirements for Ruppia cirrhosa and Potamogeton pectinatus growth, macrophyte versus phytoplankton biomass and production features, and differences in hydrological and nutrient balances between Tancada lagoon (Spain, on the Mediterranean Sea, where macrophytes from dense beds) and Encanizada lagoon (with no macrophytes at all), several proposals for macrophyte restoration are presented. The highest efficiency of R. cirrhosa takes place at high irradiance and it grows over a wide range of salinity. P. pectinatus is better adapted to lower light intensity and salinity than Ruppia. R. cirrhosa transplanted from Tancada to Encanizada was successful in enclosures, where light availability increased, but not in open water were light extinction coefficient was 0.032/cm. Phytoplankton biomass (0.11-2.15 g C/sq m) is much lower than macrophyte biomass (16-200 g C/sq m/yr) in Tancada lagoon. However, phytoplankton production (165 g C/sq m/yr in Tancada, 480 g C/sq m/yr in Encanizada) is the same order of magnitude as macrophyte production (244-467 g C/sq m/yr). Turnover rates are 0.3-0.9/day for phytoplankton and 1.2-2.5/yr for macrophytes. Phytoplankton and inorganic particles are responsible for high turbidity of the water in Encanizada lagoon. Phytoplankton blooms in Encanizada lagoon are supported by high freshwater inflows from rice field drains from May to November. The seawater discharge/freshwater discharge ratios are, respectively, 0.24 and 0.48, which denote a higher seawater influence in Tancada than in Encanizada lagoon. Decreasing freshwater inputs to Encanizada lagoon both in May and November, thus allowing greater inputs of seawater, is proposed as the most effective way to restore this eutrophic coastal lagoon. (Author's abstract)
W91-03797

ZEBRA MUSSELS (DREISSENA POLYMORPHA): A NEW PERSPECTIVE FOR WATER QUALITY MANAGEMENT.
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
H. H. Reeders, and A. Bij de Vaate.
Hydrobiologia HYDRB8, Vol. 200/201, p 437-450, August 27, 1990. 9 fig, 1 tab, 41 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Bioremediation, *Limnology, *Mussels, *Netherlands, In situ tests, Lake Wolderwijd, Phytoplankton, Suspended matter, Temperature effects.

In the evaluation of the role of lake restoration programs, in situ measurements of the filtration rate of the freshwater mussel Dreissena polymorpha were performed in Lake Wolderwijd, The Netherlands. The filtration rate depends mainly on the suspended matter content of the water, and shows an inverse exponential relationship with this factor. The filtration activity is temperature indifferent between approx. 5 and 20 C. At low temperatures the filtration rate drops abruptly; at high temperatures a gradual inhibition occurs. The filtration rate shows a sigmoidal relation with the length of the mussel. The largest D. polymorpha have a diminished filtration rate compared with animals of smaller size. This might be a degenerative feature of the oldest mussels. In Lake Wolderwijd a population density of 675 mussels per sq m is required to compensate phytoplankton growth by grazing. Manipulation of the size of the population can be executed by adding suitable substrates for the mussel. (Author's abstract)
W91-03798

SHOALS OF DREISSENA POLYMORPHA AS A BIO-PROCESSOR OF SESTON.
Nicholas Copernicus Univ. of Torun (Poland). Inst. of Biology.
R. Wisniewski.
Hydrobiologia HYDRB8, Vol. 200/201, p 451-458, August 27, 1990. 6 fig, 2 tab, 25 ref.

Descriptors: *Biomanipulation, *Bioremediation, *Lake restoration, *Limnology, *Mussels, *Seston, Animal behavior, Lake Druzno, Lake Parteczyny, Lake management, Poland, Suspended sediments.

Mussels of Dreissena polymorpha were collected from the mesotrophic Lake Parteczyny (Poland), where the species occurs in the form of a narrow, but very dense, shoal. Size-sorted mussels were allowed to colonize plastic plates in the laboratory. The plates were then transported to the shallow, eutrophic Lake Druzno, where D. polymorpha has been absent in recent years. A set of plates were exposed in lake water to which a fine fraction of

sediment was added. The resulting concentration of suspended matter was slightly higher than that found during intensive sediment resuspension. During the first 10-30 min of exposure to suspension mussels kept their valves closed, but after this time they continued filtration. The results showed that the relatively high concentration of sediment added to lake seston does not affect clearance capacity of suspension in D. polymorpha and even enhanced it. It is suggested that collection of plates colonized by D. polymorpha can be useful in the bioremediation of shallow lakes, rich in phytoplankton, with muddy bottom deposits that restrict the natural occurrence of the mussel. (Rochester-PTT)
W91-03799

HYDROPHYTE-MACROINVERTEBRATE INTERACTIONS IN ZWEMLUST, A LAKE UNDERGOING BIOMANIPULATION.
Akademia Rolnicza, Lublin (Poland). Dept. of Zoology and Hydrobiology.
R. Kornijow, R. D. Gulati, and E. van Donk.
Hydrobiologia HYDRB8, Vol. 200/201, p 467-474, August 27, 1990. 4 fig, 2 tab, 30 ref.

Descriptors: *Aquatic plants, *Biocontrol, *Biomanipulation, *Bioremediation, *Lake restoration, *Limnology, *Macroinvertebrates, *Macrophytes, *Netherlands, Algae, Cycling nutrients, Food chains, Lake Zwemlust, Lake management.

In two years after biomanipulation of Lake Zwemlust (The Netherlands), macrophytes (helophytes, elodeids) and filamentous algae developed luxuriantly in the lake. They influenced the structure of macroinvertebrate communities inhabiting them. Macrophytes and algae, by changing environmental and trophic conditions, also affected the composition of the macrobenthos. Vascular plants served as an important source of food for zoobenthos and phytofauna, mainly after they were decomposed. Filamentous algae were consumed alive by many animals. Invertebrates appeared to be important as a potential nutrient source for hydrophytes. (Author's abstract)
W91-03801

MULTIPLICITY OF STABLE STATES IN FRESHWATER SYSTEMS.
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
For primary bibliographic entry see Field 2H.
W91-03802

QUANTIFYING THE FOOD WEBS OF LAKE BLEISWIJKSE ZOOM AND LAKE ZWEMLUST.
Waterloopkundig Lab. te Delft (Netherlands).
For primary bibliographic entry see Field 2H.
W91-03803

BIOMANIPULATION ADDITIONAL TO NUTRIENT CONTROL FOR RESTORATION OF SHALLOW LAKES IN THE NETHERLANDS.
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
S. H. Hosper, and E. Jagtman.
Hydrobiologia HYDRB8, Vol. 200/201, p 523-534, August 27, 1990. 3 fig, 4 tab, 38 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Lake restoration, *Limnology, *Netherlands, *Water quality control, Aquatic plants, Bream, Eutrophic lakes, Fisheries, Food chains, Macrophytes, Roach, Shallow water, Submerged plants, Transparency, Turbidity, Zooplankton.

Eutrophication control is one of the major environmental policy issues in The Netherlands. As a result of international action programs, the average P loading of freshwater systems should decrease by 50% between 1985 and 1995. However, in many cases the restoration of water quality requires additional measures. Recovery is hampered by the structure and functioning of the present food chain. The feeding behavior of the dominant fish in Dutch lakes, bream and roach, tends to impose a homeostasis on the system, resisting restoration of water quality. In shallow lakes, biomanipulation, including drastic reduction of fish stocks, may induce a shift from a stable 'turbid-water state' to a stable 'clear-water state.' Two questions relevant to assessment of the potential of biomanipulation for the restoration of a particular lake are discussed: (1) is drastic reduction of fish-stocks feasible and (2) will a shift occur from 'turbid' to 'clear' after the fish reduction. The increase in water clarity following fish reduction largely depends on the increase in the density of the Daphnia population and the contribution of benthivorous fish to the resuspension of sediments. A 'turbid' to 'clear' shift may be expected if the total biomass of planktivorous and benthivorous fish is reduced to levels < 50 kg/ha. The stability of the achieved clear-water state depends largely on the development of submerged macrophytes in the lake and on the level of nutrient loading. It is tentatively concluded that a stable clear-water state may be expected at initial total-P concentrations < 0.10 mg/l. Because the water managers of The Netherlands have no fishing rights, they must cooperate with anglers and commercial fishermen to apply biomanipulation as a tool for water management. (Author's abstract)
W91-03804

BIOMANIPULATION DEVELOPMENT IN NORWAY.
Direktoratet for Vilt og Ferskvannsfisk, Trondheim (Norway).
A. Langeland.
Hydrobiologia HYDRB8, Vol. 200/201, p 535-540, August 27, 1990. 1 fig, 2 tab, 21 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Fish management, *Lake management, *Lake restoration, *Norway, *Water quality control, Algae, Biomass, Chlorophyta, Cyanophyta, Ecosystems, Fish, Lake Langvatn, Phytoplankton, Rotifers, Water chemistry, Zooplankton.

Since 1974 several studies have been carried out in Norway to investigate the interactions between planktivorous fish, zooplankton, phytoplankton, and water chemistry. Since 1978 a long-term national research program has been conducted by the Norwegian Council for Scientific and Industrial Research. In this program several whole-lake manipulations of the fish stocks were performed to test hypotheses about trophic interactions. It was predicted that manipulations of planktivorous fish populations might improve water quality in lakes undergoing eutrophication. Two examples illustrate the results achieved. First, results of the whole-lake fertilization experiment conducted from 1974-1978 at Lake Langvatn revealed the importance of top-down effects in the lake ecosystem. When cladocerans dominated, the zooplankton community was able to maintain a more or less constant phytoplankton biomass and a rather low phytoplankton production even when nutrient levels were increased. During years with rotifer dominance, algal biomass and productivity increased, despite the low amounts of added nutrients. The second experiment, which was performed in the eutrophic Lake Haugatjern, included total elimination of the fish population with rotenone in late 1980. This was followed by a four-fold decrease in algal biomass. The species composition changed from the dominance of large-sized Anabaena flos-aquae and Staurastrum luetkemeulleri to smaller, fast-growing species and gelatinous green algae. Although the potential benefits of biomanipulation are clear, use of the technique is a challenge for fishery biologists and managers because knowledge is insufficient concerning how to control the density of fish stocks. Increased energy transfer to fish also may improve the recreational fishery. (Rochester-PTT)
W91-03805

REVIEW: LIMNOLOGICAL MANAGEMENT AND BIOMANIPULATION IN THE LONDON RESERVOIRS.
Royal Holloway and Bedford New Coll., Egham (England). Dept. of Biology.
A. Duncan.
Hydrobiologia HYDRB8, Vol. 200/201, p 541-548, August 27, 1990. 4 fig, 25 ref.

Descriptors: *Biocontrol, *Biomanipulation, *England, *Lake restoration, *Limnology, *Reservoir operation, *Reservoirs, *Water quality control, Algae, Biomass, Ecosystems, Fish, London, Transparency, Zooplankton.

Low algal biomasses and high water transparencies are a feature of the storage reservoirs that supply most of London's treated water. This results from knowledgeable limnological management and biomanipulation and despite the eutrophic nature of the River Thames with its high nutrients (7 g N/cu m, 1 g P/cu m) and particulate organic carbon (2 g C/cu m). Built-in possibilities of jetting input water are managed to prevent stratification, to ensure isothermy, to mix chemicals and plankton vertically and horizontally, and to manipulate the mixed-depth of the algal populations such that their potential for biomass growth is reduced by light-energy limitation. Spring algal growth is delayed and the spring peak is reduced and curtailed by the grazing impact of considerable biomasses of large-bodied daphnid populations (Daphnia magna, pulicaria, and hyalina) whose development also is supported by the continuous input of high crops of riverine algae. The existence of a large-bodied daphnid zooplankton in the reservoirs is associated with low levels of fish predation since the late 1960s. Variations in the intensity and nature of this vertebrate predation during the period 1968-1988 are illustrated by the changes that have occurred in the relationship between the phytoplankton and zooplankton biomasses of the April-May-June quarter of the year. This example of the London reservoirs shows that biomanipulation of deep water bodies has bottom-up as well as top-down effects. (Author's abstract)
W91-03806

POTENTIAL FOR BIOMANIPULATION USING FRY COMMUNITIES IN A LOWLAND RESERVOIR: CONCORDANCE BETWEEN WATER QUALITY AND OPTIMAL RECRUITMENT.
Lodz Univ. (Poland). Inst. of Environmental Biology.
M. Zalewski, B. Brewinska-Zaras, P. Frankiewicz, and S. Kalinowski.
Hydrobiologia HYDRB8, Vol. 200/201, p 549-556, August 27, 1990. 8 fig, 27 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Lake restoration, *Limnology, *Poland, *Reservoir operation, *Reservoirs, *Water quality control, Animal populations, Carp, Crustaceans, Daphnia, Fish management, Monitoring, Perch, Phytoplankton, Reproduction, Slejow Reservoir.

The fry community in Slejow Reservoir, central Poland, a temperate lowland reservoir, was monitored for 7 yr. The variation in reproductive success of the dominant perch and cyprinids was correlated with the variation of the water level. During summer the main food of perch was Daphnia. In the year with the highest density of perch, a decline in the density of cladocerans and in the percentage of Daphnia eaten was observed. This resulted in low stomach fullness and poor fry growth. Simultaneously, the amount of phytoplankton increased. An optimal recruitment curve was found for maintaining water quality with optimal recruitment of fish stocks, assuming that a high rate of fry growth is essential for survival during winter. Regulation of fry density can be achieved by manipulation of water levels during the reproductive and early ontogeny periods. (Author's abstract)
W91-03807

RESTORATION OF SHALLOW EUTROPHIC LAKES, AND THE ROLE OF NORTHERN PIKE, AQUATIC VEGETATION, AND NUTRIENT CONCENTRATION.
Witteveen and Bos, Deventer (Netherlands).
M. P. Grimm, and J. J. G. M. Backx.
Hydrobiologia HYDRB8, Vol. 200/201, p 557-566, August 27, 1990. 5 fig, 5 tab, 37 ref.

Descriptors: *Aquatic vegetation, *Biocontrol, *Biomanipulation, *Eutrophic lakes, *Fish man-

agement, *Lake restoration, *Limnology, *Netherlands, *Water pollution treatment, Biomass, Ecosystems, Phosphorus, Pike, Predation, Shallow water, Water quality.

The feasibility of biomanipulation is related particularly to reducing the production and recruitment of planktivorous fish stocks. For assessing the level of predation needed to suppress planktivorous fish stocks, the relation between fish production and biomass, on one hand, and nutrient concentration on the other were analyzed based on data obtained from several years of investigation at various sites in The Netherlands. The carrying capacity of shallow lakes in terms of biomass is related to the total phosphorus concentration and the nature of the lake bottom substrate. The production of planktivorous fish was 60-80% of the maximum carrying capacity. Aquatic vegetation and northern pike appear to be effective tools for maintaining water quality, but they are limited by the maximum nutrient concentration aquatic vegetation can sustain. (Author's abstract)
W91-03808

EFFECTS OF PLANKTIVOROUS FISHES ON THE PLANKTON COMMUNITY IN A EUTROPHIC LAKE.
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
For primary bibliographic entry see Field 2H.
W91-03809

EXPERIMENTAL STUDY OF THE IMPACTS OF PLANKTIVOROUS FISHES ON PLANKTON COMMUNITY AND EUTROPHICATION OF A TROPICAL BRAZILIAN RESERVOIR.
Companhia de Agua e Esgotos de Brasilia (Brazil). Secao de Estudos de Poluicao Hidrica.
F. L. R. M. Starling, and A. J. A. Rocha.
Hydrobiologia HYDRB8, Vol. 200/201, p 581-591, August 27, 1990. 4 fig, 2 tab, 36 ref.

Descriptors: *Algal control, *Biocontrol, *Biomanipulation, *Brazil, *Eutrophic lakes, *Lake restoration, *Limnology, *Water quality control, Bluegills, Carp, Cyanophyta, Eutrophication, Fish management, Food chains, Paranoa Reservoir, Phytoplankton, Reservoir operation, Rotifers, Tilapia.

The impacts of three facultative planktivorous fishes, Congo tilapia (Tilapia rendalli), bluegill (Lepomis macrochirus), and tambaqui (Colossoma macropomum), and an obligate planktivorous fish, silver carp (Hypophthalmichthys molitrix), on the plankton community and water quality of Paranoa Reservoir (Brazil), a typical eutrophic reservoir, were examined using both selective grazing experiments in the laboratory and an enclosure experiment. The first two species inhabit this reservoir and the remaining two are recommended for introduction. The field experiment was performed in 10 limnocorrals of 2 cu m each and lasted 5 wk. During the enclosure experiment, silver carp suppressed copepod nauplii, cladocerans and rotifers while the presence of tilapia and bluegill was associated with increased rotifer density. The dominant blue-green alga, Cylindrospermopsis raciborskii (98% of phytoplankton biomass) was enhanced in the presence of bluegill, tilapia, and tambaqui, but reduced in the presence of silver carp. This impact on plankton is in agreement with the results of the laboratory feeding trials. The control of the undesirable alga C. raciborskii by silver carp grazing appears to be a promising management tool based on the present results. (Author's abstract)
W91-03810

SOME POSITIVE AND NEGATIVE EFFECTS OF STOCKING WHITEFISH ON THE ECOSYSTEM REDEVELOPMENT OF HJARBAEK FJORD, DENMARK.
Viborg Amtskommune (Denmark). Environmental Dept.
K. Rasmussen.
Hydrobiologia HYDRB8, Vol. 200/201, p 593-602, August 27, 1990. 7 fig, 1 tab, 14 ref.

Descriptors: *Biocontrol, *Biomanipulation, *Denmark, *Fish management, *Fjords, *Limnology, *Water quality control, *Whitefish, Benthos, Eutrophic lakes, Fish stocking, Hjarbaek Fjord, Midges, Plankton.

In 1984 the County of Viborg (Denmark) introduced a large-scale program to improve the water quality in Hjarbaek Fjord, a freshwater fjord cut off from the sea in 1964. Measures were taken to reduce the discharges of nutrients from various sources. To reduce the nuisance of chironomids a large release of whitefish (Coregonus lavaretus L.) was incorporated into the program. The effects of these remediation efforts on the fish, benthos, and plankton communities were studied during a period of 5 yr. The whitefish established a self-reproducing population with a very good growth rate, and may have created quantitative and qualitative changes in the plankton community. Observed changes in the benthos community also may be related to predation by whitefish. The study did not confirm that whitefish could actually control the population of chironomids. The stocking of whitefish created an exploitable fishery of valuable species in the hypertrophic Hjarbaek Fjord. (Author's abstract)
W91-03811

ZOOPLANKTON IMPACTS ON CHLOROPHYLL AND TRANSPARENCY IN ONONDAGA LAKE, NEW YORK.
Michigan Technological Univ., Houghton. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2H.
W91-03812

REVIEW OF IMMISCIBLE FLUIDS IN THE SUBSURFACE: PROPERTIES, MODELS, CHARACTERIZATION AND REMEDIATION.
GeoTrans, Inc., Herndon, VA.
For primary bibliographic entry see Field 5B.
W91-03847

STORM WATER MANAGEMENT MODEL FOR URBAN AREAS IN KUWAIT.
Kuwait Univ., Safat. Dept. of Civil Engineering.
N. A. Zaghloul, and A.-R. M. Al-Shurbaji.
Water Resources Bulletin WARBAQ, Vol. 26, No. 4, p 563-575, August 1990. 8 fig, 3 tab, 14 ref.

Descriptors: *Computer models, *Kuwait, *Storm runoff, *Storm water management, *Urban runoff, Computers, Flood hydrographs, Mathematical analysis, Mathematical models, Storm sewers, Urban drainage, Urban hydrology.

A comprehensive study was conducted to implement the Storm Water Management Model (SWMM) for urban areas in Kuwait. The updated version of the model designed to run on an IBM Personal Computer and compatibles was utilized. Urban runoff simulation in arid areas by the SWMM model is a powerful and efficient tool in designing drainage systems and as such, a viable replacement of the commonly used rational method. It was found that only the streets and paved areas that are hydraulically connected to the drainage system contribute to runoff. Fine and coarse discretization approaches were used in the study. The difference between the hydrographs simulated by the two approaches were relatively small. The performance of the existing drainage system and the accuracy of the design method used were tested using a 25-year storm. The result of the simulation revealed that the storm sewers were oversized by factors ranging from 1.2 to 3.6. The SWMM model was used to estimate the storm water runoff volume collected from all urbanized areas in Kuwait City. The annual expected harvested runoff water was found to be significant; however, the quality of runoff water needs to be assessed before a decision is made on its reuse. (Author's abstract)
W91-03852

PREDICTION, VALIDATION, MONITORING, AND MITIGATION OF ANTHROPOGENIC EFFECTS UPON NATURAL SYSTEMS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 5C.
W91-03871

BACTERIAL CONTAMINATION AND REMEDIATION MEASURES AT MARINA DEL REY, CALIFORNIA, U.S.A.
Los Angeles County Dept. of Beaches and Harbors, CA.
For primary bibliographic entry see Field 5B.
W91-03872

BINATIONAL MANAGEMENT OF HAZARDOUS WASTE: THE MAQUILADORA INDUSTRY AT THE US-MEXICO BORDER.
California Univ., Los Angeles. School of Public Health.
D. M. Perry, R. Sanchez, W. H. Glaze, and M. Mazari.
Environmental Management EMNGDC, Vol. 14, No. 4, p 441-450, 1990. 8 fig, 1 tab, 29 ref. California Department of Health Services Contract No. 88-T0370.

Descriptors: *Hazardous wastes, *Industrial wastes, *International agreements, *Mexico, *United States, *Waste management, *Water pollution control, *Water pollution sources, Environmental policy, Legislation, Maquiladora, Path of pollutants, Public health, Volatile organic compounds.

Foreign-owned industry in the form of assembly plants, termed maquiladora, has become very important in Mexico to the extent that it represents the second largest source of foreign exchange and is a valuable source for employment and regional development. The economic prosperity gained from the rapid growth of the maquiladora industry has been accompanied by increased environmental and human health risks associated with generation of hazardous waste. Diversification of industry has resulted in the predomination of those sectors that likely use hazardous substances. The Mexicali-Calexico border region was selected to demonstrate the potential for environmental and health risks associated with the generation of hazardous waste. Estimates for the generation of hazardous waste were obtained from 34 maquiladora plants in Mexicali, represented by the electronic and electrical equipment and parts, mechanical and transportation equipment, and toys and sporting equipment centers. Repeated detection of volatile organic compounds in the New River at the US-Mexico border suggests that hazardous waste from the printed circuit board industry in Mexicali is not being disposed of in a proper manner. Potential adverse health effects, such as carcinogenic and mutagenic responses associated with detectable volatiles, are discussed. US and Mexico national legislation and the binational environmental agreement were examined for their adequacy to ensure proper management of hazardous waste generated by the maguiladora industry. Environmental policy options are presented that focus on: (1) increased environmental accountability of US parent companies for their maquiladora assembly plants in Mexico; and (2) more integration between US Customs and border states with the EPA to improve the binational management of hazardous waste generated by the maquiladora industry. (Author's abstract)
W91-03875

HEAVY METAL ACCUMULATION BY BARNACLES AND ITS IMPLICATIONS FOR THEIR USE AS BIOLOGICAL MONITORS.
Victoria Univ. of Manchester (England). Dept. of Environmental Biology.
For primary bibliographic entry see Field 5A.
W91-03886

SALINE WATER DISPOSAL OPTIONS IN THE MURRAY BASIN.
Rural Water Commission of Victoria, Armidale (Australia). Investigations Branch.
For primary bibliographic entry see Field 3C.
W91-03891

IS BROADSCALE REVEGETATION ECONOMIC AND PRACTICAL AS A GROUNDWATER AND SALINITY MANAGEMENT TOOL IN THE MURRAY-DARLING BASIN.
La Trobe Univ., Bundoora (Australia). School of Agriculture.
For primary bibliographic entry see Field 4C.
W91-03895

ASPECTS OF STRATIGRAPHY AND STRUCTURE IN RELATION TO THE WOOLPUNDA GROUNDWATER INTERCEPTION SCHEME, MURRAY BASIN, SOUTH AUSTRALIA.
South Australian Dept. of Mines and Energy, Adelaide.
For primary bibliographic entry see Field 2F.
W91-03896

EVALUATION OF AQUIFER BEHAVIOR AND CHARACTERISTICS IN THE SINGRAULI COALFIELD, CENTRAL INDIA.
Indian School of Mines, Dhanbad. Dept. of Applied Geology.
For primary bibliographic entry see Field 2F.
W91-03914

COLUMN STUDIES ON METHANOTROPHIC DEGRADATION OF TRICHLOROETHENE AND 1,2-DICHLOROETHANE.
Sonnenschein Nath and Rosenthal, Washington, DC.
N. A. Lanzarone, and P. L. McCarty.
Ground Water GRWAAP, Vol. 28, No. 6, p 910-919, November/December 1990. 12 fig, 2 tab, 30 ref. Grant CR-81220.

Descriptors: *Aliphatic hydrocarbons, *Biodegradation, *Bioremediation, *Cleanup, *Dichloroethane, *Groundwater pollution, *Halogenated hydrocarbons, *Methane bacteria, *Trichloroethene, *Water pollution treatment, Biotransformation, Ion exchange, Propane, Sand aquifers, Soil columns.

The potential for and variables affecting enhanced aerobic biodegradation of carbon-14-labeled trichloroethene (TCE) and 1,2-dichloroethane (1,2-DCA) were evaluated using laboratory columns packed with fully-saturated sandy aquifer material. The column fluids were exchanged weekly to simulate the growth of native microorganisms capable of biotransforming halogenated aliphatics. The exchange solutions for seven columns, one of which served as a control, contained dissolved oxygen as the electron acceptor. The electron donor for another column was dissolved propane, while the remaining five columns were fed varying concentrations of dissolved methane. Propane was not consumed, and TCE degradation did not occur in this column. However, methane was utilized in other columns, and the resulting stimulated populations mineralized both TCE and 1,2-DCA to CO2. Little or no TCE degradation occurred when the methane concentration was 4.5 mg/L, but did when the methane was reduced to 1.5 mg/L. TCE degradation was greatest when either a low methane concentration (1.5 mg/L) or an alternating pulse of methane with oxygen one week followed by oxygen only the next was used. Nutrient supplements did not conclusively enhance TCE degradation. When TCE addition was stopped and methanotrophic bacteria stimulation was continued, half of the carbon-14 from previously sorbed TCE that was subsequently eluted by exchange was present as nonvolatile compounds and CO2, and the other half as TCE. Although the results are site-specific, they do suggest that the addition of methane and oxygen to water circulated through a groundwater system to remove TCE by aboveground treatment can, in some cases, result in a doubling of the rate of removal and effect mineralization of about one-half of the TCE removed. (Author's abstract)
W91-03916

SELECTION OF SURFACTANTS FOR THE REMOVAL OF PETROLEUM PRODUCTS FROM SHALLOW SANDY AQUIFERS.
General Motors Research Labs., Warren, MI. Environmental Science Dept.
A. S. Abdul, T. L. Gibson, and D. N. Rai.
Ground Water GRWAAP, Vol. 28, No. 6, p 920-926, November/December 1990. 1 fig, 7 tab, 11 ref.

Descriptors: *Cleanup, *Groundwater pollution, *Hydrocarbons, *Soil contamination, *Surfactants, *Water pollution treatment, Alcohols, Colloids, Detergents, Dispersion, Nonionic surfactants, Phenols, Sand, Sand aquifers, Soil columns, Solubility, Sulfates, Sulfonates, Turbidity.

Soil and groundwater contamination by petroleum products, such as gasoline and oils, is widespread. A laboratory study was conducted to evaluate the relative suitability of 10 commercial surfactants for washing residual levels of automatic transmission fluid (ATF) from sandy material. The surfactants included at least one example for each of four main groups of commercial surfactants: (1) ethoxylated alcohols (nonionic), (2) ethoxylated nonylphenols (nonionic), (3) sulfates (anionic), and (4) sulfonates (anionic). Several properties of aqueous solutions of the surfactants (0.00001 to 5.0% v/v) were measured and used in evaluating their suitability. The extent of dispersion of soil colloids was measured as the turbidity (in formazin turbidity units, FTU) of soil/surfactant solution mixtures. The detergency of the surfactant solutions and the extent to which they solubilized the ATF were measured. The critical micelle concentration, which ranged from 0.05 to 5.0 percent, was measured and used to select the aqueous concentration of the surfactants in washing experiments. The amount of ATF removed from the sand ranged from about 23% by washing with water to more than 80% by washing with ethoxylated alcohol surfactants. ATF was best removed from the soil by washing with a 0.5% aqueous solution of either alkoxylated alcohol ether, ethoxylated alcohol, or nonylphenol ether sulfate. An ethoxylated alcohol surfactant was selected for scale-up laboratory and field tests because this surfactant caused low soil-colloid dispersion and high ATF dispersion and solubilization, and was effective in washing ATF from the soil. (Author's abstract)
W91-03917

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

WATER-RESOURCES PROGRAMS AND HYDROLOGIC-INFORMATION NEEDS, MARION COUNTY, INDIANA, 1987.
Geological Survey, Indianapolis, IN. Water Resources Div.
R. F. Duwelius.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-159, 1990. 24p, 6 fig, 47 ref.

Descriptors: *Data acquisition, *Indiana, Groundwater, Interagency cooperation, Surface water, Water quality, Water resources organizations, Water use.

Water resources are abundant in Marion County, Indiana, and have been developed for public and industrial supply, energy generation, irrigation, and recreation. The largest water withdrawals are from surface water, and the two largest water uses are public supply and cooling water for electrical-generating plants. Water-resources programs in the county are carried out by Federal, State and local agencies to address issues of surface and groundwater availability and quality. The programs of each agency are related to the functions and goals of the agency. Although each agency has specific information needs to fulfill its functions, sometimes these needs overlap, and there are times when the same hydrologic information benefits all. Overlapping information needs and activities create opportunities for interagency coordination and cooperation. Such cooperation could lead to a savings of dollars spent on water-resources programs and could assure an improved understanding of the water resources of the county. Representatives from four agencies--the Indiana Department of Environmental Management, the Indiana Department of Natural Resources, the Indianapolis Department of Public Works, and the U.S. Geological Survey--met four times in 1987 to describe their own water-resources programs, to identify hydrologic-information needs, and to contact other agencies with related programs. This report presents the interagency findings and is intended to further communication among water resource agencies by identifying current programs and common needs for hydrologic information. Hydrologic information needs identified by the agency representatives include more precise methods for determining the volume of water withdrawals and for determining the volume of industrial and municipal discharges to surface water. Maps of flood-prone areas need to be updated as more of the county is developed. Improved aquifer maps of the inter-till aquifers are needed, and additional observation wells are needed in the inter-till and bedrock aquifers. Finally, immediate access to instantaneous precipitation data is needed to assess flooding potential. (USGS)
W91-02967

DEVELOPMENT OF SYSTEMS.
Michigan State Univ., East Lansing. Inst. of Water Research.
For primary bibliographic entry see Field 7C.
W91-02989

ROLE OF ENVIRONMENTAL MODELING IN THE DECISION-MAKING PROCESS.
For primary bibliographic entry see Field 5G.
W91-02996

WATER: LAWS AND MANAGEMENT.
For primary bibliographic entry see Field 6E.
W91-03032

COST SHARING: IT'S IMPACT ON WATER RESOURCES DEVELOPMENT.
Military Academy, West Point, NY. Dept. of Electrical Engineering.
For primary bibliographic entry see Field 6C.
W91-03034

REGIONAL WATER MANAGEMENT AGENCY INVOLVEMENT IN LOCAL GOVERNMENT COMPREHENSIVE PLANNING.
Southwest Florida Water Management District, Brooksville.
R. W. Frahm, and R. A. Christianson.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 1B-1--1B-10, 2 fig, 3 ref.

Descriptors: *Florida, *Land use, *Local governments, *Regional planning, *Water management, *Water resources management, Decision making, Evaluation, Information exchange, Management planning, Public policy, Southwest Florida Water Management District.

The Southwest Florida Water Management District (SWFWMD) has broad responsibilities for the management of water resources over a region that includes all or part of 16 counties. In response to the growth management legislation adopted by the state of Florida in 1984 and 1985, each of the 97 local governments within the SWFWMD is required to prepare a comprehensive plan. These local planning efforts represent a unique opportunity to enhance water resources protection through the coordination of land and water management. Local land use and planning decisions impact water resources significantly, especially in the context of the rapid growth currently taking place in the SWFWMD to strengthen intergovernmental coordination and improve water resource management. The four primary elements of this program include information and technical assistance, policy guidance, comprehensive plan review and comment, and follow-up assistance to aid in the implementation of local plans. (See also W91-03032) (Author's abstract)
W91-03036

WATER MANAGEMENT PLANNING: A PERSPECTIVE FROM THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT.
Southwest Florida Water Management District, Brooksville.
R. S. Owen, and H. D. Levine.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 1B-11--1B-19, 2 exhibits.

Descriptors: *Florida, *Management planning, *Southwest Florida Water Management District, *Water management, *Water resources management, Decision making, Information exchange, Public policy, Public utility districts, Regulations.

Planning initiatives at the Southwest Florida Water Management District include both formal and informal efforts and practices. Different efforts are identified with particular emphasis given to the development of strategic planning and how it may serve to consolidate budget and program planning within the District. Several strategic planning goals are presented: (1) data collection and analysis which is comprised of efforts to improve and expand data collection and analysis efforts at the District to insure that the governing board and staff can make well informed decisions; (2) regulation, which is a goal to continue programs and initiatives which enable the District to meet its statutory charges (provided in Chapter 373, F.S.), including regulation of water resources in the District; (3) water conservation, with regard to a continuation and expansion of programs which encourage the conservation and protection of water and water-related resources; (4) coordination, by continuing to develop and support existing programs which promote activities with other state and local agencies, the private sector and concerned citizens of the District; and (5) organizational development, which is a commitment to reviewing and modifying (if necessary) the infrastructure of the agency to ensure the quality of the services provided to the constituency of the District. (See also W91-03032) (Lantz-PTT)
W91-03037

MANAGING WATER RESOURCES BY INTEGRATING PLANNING: NEW JERSEY'S STATE PLAN.
New Jersey Dept. of the Treasury, Trenton. Office of State Planning.
For primary bibliographic entry see Field 6C.
W91-03038

RESPONSE TO THE ALABAMA ENVIRONMENTAL PROTECTION PLAN.
Water Cycle Concepts, Inc., Auburn, AL.
J. C. Warman, and D. H. Block.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 1B-35--1B-41, 2 ref.

Descriptors: *Alabama, *Environmental policy, *Environmental protection, *Legislation, *Water management, Coastal zone management, Economic aspects, Hazardous wastes, Land use, Regulations, State jurisdiction, Waste disposal, Water resources management.

The Alabama Legislature adopted a joint resolution in February 1986 establishing a 24-member Alabama Environmental Planning Council for the State of Alabama. The council members were selected to represent all geographic areas of the State and diverse segments of society. The council was organized into task forces that included: air quality, land use, coastal zone/marine resources, solid and hazardous waste, and water resources, to address the major environmental issues facing the State. The council's objective was to write a plan that balances the need to protect Alabama's environmental resources with the State's desire to continue economic growth and development. Organization of the plan includes the establishment of broad environmental goals, actions aimed at achieving the objectives, measures by which to gage the degree of progress toward each goal, and possible consequences of inaction. Early in 1989, the Plan was submitted through the Director of the Alabama Department of Environmental Management to the Governor and the Legislature. A description of comments made at these and public meetings is provided in this paper. (See also W91-03032) (Author's abstract)
W91-03039

COMPREHENSIVE WATER SHORTAGE PLANNING IN THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT.
Southwest Florida Water Management District, Brooksville.
D. Brandes.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 1B-43--1B-47.

Descriptors: *Florida, *Southwest Florida Water Management District, *Water conservation, *Water deficit, *Water management, *Water resources management, *Water supply, Drought, Economic aspects, Maintenance, Water demand, Water resources development.

Drought is often the presumed reason for a water shortage, however it should not be regarded as the exclusive cause of shortfalls in water supply. Other factors that may be responsible for water shortage include: distribution system failure, inadequate production or treatment capacity, pollution of supply sources, and excessive water use. Local water shortages may also result from inadequate planning and development of supply sources or treatment and storage facilities. These inadequacies can be caused by rapid increases in demand, or a lack of development and maintenance of supply capability. Rainfall variability only exacerbates these conditions. Water shortage planning must take into account this wide variety of circumstances which can produce shortages. This approach would recognize the diverse and complex causes of water shortages, and focus on actions to prevent, forestall, and minimize shortages as well as to mitigate their impact when they do occur. Long-term water conservation measures, reduction in demand, regulatory and economic measures, and enhancing supply are possible solutions to the water demand crisis. (See also W91-03032) (Lantz-PTT)
W91-03040

ROLE OF PLANNING IN RESOLVING WATER POLICY DISPUTES.
Montana Dept. of Natural Resources and Conservation, Helena. Water Resources Div.
M. J. McKinney.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 2B-17--2B-29, 2 fig, 33 ref.

Descriptors: *Legal aspects, *Management planning, *Project planning, *Public policy, *Water management, *Water resources development, *Water resources management, Competing use, Decision making, Water use.

In the arid West, the development and implementation of water policy often results in disputes among water users, resource managers, and policy makers. Several approaches exist to resolve these disputes, including administrative appeals, litigation and political action. Another, rarely used method for resolving water policy disputes is planning. A collaborative, consensus-building approach to water resources planning and dispute resolution offers many benefits. By including affected interests in actively determining the outcome of a dispute or a potentially controversial situation, these groups have a stake in the final decision and in seeing that it is implemented. This should avoid the costly and time consuming outcomes of unmanaged conflicts, such as administrative appeals, litigation and political action. This approach also encourages the participating individuals and groups to focus on specific water management issues rather than assuming adversarial positions which leave little room for pursuing mutually acceptable solutions. Other benefits include: the concentration of diverse perspectives and interests; the cooperative and systematic analysis of technical information; the formation of more pragmatic, equitable and mutually acceptable goals and alternatives; and the improvement of relationships among diverse, often competing water user groups, resource management agencies, and policy makers. Finally, this approach may be used to resolve other natural resource disputes and potentially controversial issues. (See also W91-03032) (Lantz-PTT)
W91-03042

POLICY EDUCATION TO BUILD LOCAL CAPACITY TO MANAGE THE RISK OF GROUNDWATER CONTAMINATION.
Cornell Univ., Ithaca, NY. Resource Economics.
For primary bibliographic entry see Field 5G.
W91-03043

WATER USE PERMITTING IN FLORIDA: AN EFFECTIVE PROGRAM FOR ALLOCATING WATER.
Saint Johns River Water Management District, Palatka, FL. Dept. of Resource Management.
For primary bibliographic entry see Field 6D.
W91-03054

IMPLEMENTATION OF AN OPERATIONAL GEOGRAPHIC INFORMATION SYSTEM FOR MULTIPURPOSE WATERSHED MANAGEMENT.
Salem State Coll., MA. Digital Geography Lab.
For primary bibliographic entry see Field 7C.
W91-03068

AMERICAN RIVER AND AUBURN DAM: AN EXAMPLE OF THE NEW WATER POLICY.
California State Univ., Sacramento. Dept. of Economics.
K. Calandri.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 12A-27--12A-32, 10 ref.

Descriptors: *American River, *Auburn Dam, *Public policy, *Water policy, *Water resources development, Dams, Decision making, Flood control, Public participation, Water supply development.

In 1965 the construction of Auburn Dam, California was authorized by Congress to provide a multipurpose dam on the American River for water, power, and flood control. In the following 25 years, the dam has not been built, and the need for this dam has been questioned despite the continuing increases in the demand for water, power, and flood control. Highlighted in this paper are the changing views of water usage (economic, as well as technical and legal innovations) over the last 25 years in order to determine the best way to provide for the increasing needs of the region and to ensure the environmental protection and instream uses for the water. The new views of the Bureau of Reclamation and the federal government as to cost sharing, dry dams, as well as the more efficient use of existing supplies have lead the author to believe that the correct decision over the construction of the dam will be made in the near future. In the new legal framework with the recognition of states rights, fisheries and downstream users, such as the Delta, and lower American River, will help achieve the needed equity in the water system. With the new tools, however, regardless of what happens with the Auburn unit, the decisions made will be better than those that were made 20-25 years ago. (See also W91-03032) (Lantz-PTT)
W91-03079

STRINGFELLOW HAZARDOUS WASTE SITE: COMPUTERIZED DATA MANAGEMENT.
CH2M Hill, Santa Ana, CA.
For primary bibliographic entry see Field 7C.
W91-03080

SILVICULTURE BEST MANAGEMENT PRACTICES-A COMPREHENSIVE ASSESSMENT.
Florida Div. of Forestry, Tallahassee.
For primary bibliographic entry see Field 5G.
W91-03083

INTERBASIN WATER TRANSFERS: A MANAGEMENT APPROACH FOR PHOENIX'S WATER FUTURE.
Montgomery (James M.) Consulting Engineers, Inc., Pasadena, CA.
R. C. Siemak.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 11B-3--11B-18, 7 fig, 2 tab.

Descriptors: *Arizona, *Interbasin transfers, *Phoenix, *Water management, *Water resources development, *Water resources management, Agricultural water, Financial aspects, Groundwater quality, Groundwater resources, McMullen Valley, Project planning.

To meet the City's future water needs, Phoenix investigated the feasibility of the purchase of 14,000 acres in the McMullen Valley (an agricultural area 80 miles west of Phoenix), the retirement of the land from production, and the exportation of the underlying groundwater to Phoenix. The evaluation included assessing the groundwater characteristics of the basin, determining facility requirements, estimating project costs, developing methods of conserving the existing groundwater supply in the early years of the project, and investigating the socio-economic impacts of the purchase on the Valley's residents and county government. Based on the evaluation of the technical and socio-economic aspects of the project, the development of the McMullen Valley for exportation of groundwater to the City of Phoenix is economically feasible. The study area has over 6 million acre-feet (AF) of good-to-excellent quality groundwater available. An annual exportation of 30,000 AF/yr is possible without severely impacting groundwater levels or well extraction production. The present agricultural economy within the McMullen Valley is declining and is expected to continue in a downward trend. Thus, a water conservation plan that includes retirement of farm lands would have a minimal impact on the area's agricultural economy. Loss of tax revenue may be mitigated by an in-lieu tax payment program. Other mitigation programs have been proposed to aid the McMullen Valley Community. (See also W91-03032) (Lantz-PTT)
W91-03085

WATER-RESOURCES DEVELOPMENT ALTERNATIVES FOR THE MISSISSIPPI ALLUVIAL PLAIN IN EASTERN ARKANSAS.
Geological Survey, Little Rock, AR. Water Resources Div.
G. L. Mahon, J. E. Terry, and R. C. Peralta.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 11B-29--11B-43, 6 fig, 2 tab, 15 ref.

Descriptors: *Alternative planning, *Arkansas, *Mississippi-Missouri River Basin, *Water resources development, *Water resources management, Aquifers, Federal jurisdiction, Groundwater resources, Hydrologic models, Model studies, State jurisdiction.

Effective management of the water resources of the Mississippi Alluvial Plain in eastern Arkansas involves understanding the nature of existing problems, estimating total water demands, predicting how much of the total demand can be provided by the underlying aquifer and available surface water sources, and deducing how much water must come from alternate sources. Various Federal and State agencies have cooperatively provided hydrologic information for the area to evaluate water resources development alternatives insuring that: (1) the use of water from the aquifer be maximized while maintaining a minimum of 20 feet of saturated thickness, (2) the use of surface water be maximized where it is currently available, and (3) alternate sources of water (surplus surface water) be identified for use in deficit areas. Water resources development alternatives are being evaluated by using digital groundwater flow and optimization models. The optimization model is used to maximize withdrawals from the aquifer and from available surface water sources, while maintaining a minimum saturated thickness in the aquifer. The validity of predictions in both the flow and optimization models depends on the accuracy of historic and projected water use. Optimization model by-products include estimates of unmet water use demands and the location of surplus surface water that would be available for transport to and utilization in water deficient areas. (See also W91-03032) (Author's abstract)
W91-03087

PROMOTING REGIONAL WATER SUPPLY DEVELOPMENT: A CASE STUDY FROM SOUTHWEST FLORIDA.
Southwest Florida Water Management District, Brooksville.
For primary bibliographic entry see Field 6E.
W91-03088

PLANNING TOOL FOR WATER CONSERVATION.
Brown and Caldwell, Tampa, FL.
J. Salgaonkar.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 13B-5--13-B-11, 1 fig, 1 tab, 5 ref.

Descriptors: *Computer programs, *Cost-benefit analysis, *Water conservation, *Water resources management, *Water use, Management planning, Southwest Florida Water Management District.

An easy to use spreadsheet program was developed to evaluate total watershed savings and the relative cost-effectiveness of various water conservation measures. The program can be used with commercially available software such as LOTUS 1-2-3 and Symphony. When utility specific information is inserted into specific cells the formulas imbedded in the program calculate the cost-benefit ratios and total water savings over the planning period. For the measures analyzed for the Southwest Florida Water Management District achievable water savings ranged from less than 1% up to as much as 15% of the projected usage. This reduction in water usage will help extend supplies, decrease wastewater flows, reduce energy consumption and stabilize the demands of rapid population growth. A rigorous cost-benefit analysis provides the following advantages: (1) it provides data needed to plan for future growth; (2) it supports the budget/planning process required to implement new conservation programs; (3) it gives the agency staff and its board of directors a sound basis for implementing the needed water conservation measures to achieve the projected water savings; and (4) it demonstrates to the public that the water agency has thoroughly investigated water conservation options before approving any new capital projects to accommodate new growth. (See also W91-03032) (Lantz-PTT)
W91-03091

GENERALIZED MODEL OF THE REQUIRED STORAGE CAPACITY.
Sarajevo Univ. (Yugoslavia). Inst. of Water Resources Engineering.
For primary bibliographic entry see Field 4A.
W91-03546

SECOND CONFERENCE ON THE MANAGEMENT OF THE ILLINOIS RIVER SYSTEM: THE 1990S AND BEYOND.
Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. 199p. Edited by Holly Korab.

Descriptors: *Conferences, *Illinois, *Illinois River, *Water resources development, *Water resources management, *Watershed management, Federal jurisdiction, Local governments, Management planning, Resources management, State jurisdiction, Water quality.

The Illinois River Watershed has been the focus of public concern and countless research studies for decades. In April 1987, approximately 200 people gathered in Peoria, Illinois for the First Conference on the Management of the Illinois River System. Here, the participants discussed problems of the Illinois River System, indicated priorities, and identified ways to manage a solution. Since this time, a great deal of progress has taken place throughout the Illinois River Watershed. This second conference was held to provide an open public forum for discussion of program thrusts, actions, and solutions since the first conference and promote continuing public awareness and action. The papers presented at this conference and presented in these proceedings, fall into three broad categories (Illinois State Water Plan Task Force; Local Initiatives; and The Federal Perspective), and discuss topics ranging from the 'Water Quality Impacts of Illinois River Commercial Navigation' to 'Long-Term Resources Monitoring on the Illinois River. (See W91-03609 thru W91-03632) (Lantz-PTT)
W91-03608

ILLINOIS DEPARTMENT OF CONSERVATION'S CHANGING ROLE IN THE ILLINOIS RIVER BASIN.
Illinois Dept. of Conservation, Springfield.
For primary bibliographic entry see Field 6E.
W91-03609

WATERWAYS--THEIR RECREATIONAL POTENTIAL.
Heartland Water Resources Council, Peoria, IL.
B. Noble.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 36-40.

Descriptors: *Illinois, *Illinois River, *Recreation, *Water resources management, Land use, Resources management, Social aspects, State jurisdiction, Water use.

In Peoria, the Illinois River has the potential for becoming the focal point of the community. The two expansive lakes of the Illinois River provide not only visual enhancement, but also help to solve the aquatic recreational needs of people throughout central Illinois. Throughout history, the Illinois River has always been an important migration route for ducks, rivaling and actually exceeding the Mississippi flyway to earn the reputation as the choice duck hunting area in the US. The Peoria District, with the aid of the Forest Park Foundation and Federal and State matching funds through the State of Illinois Department of Conservation (DOC), has preserved over 4.2 linear miles of riverfront in the City of Peoria and Village of Peoria Heights. A nature preserve, Galena Marina, and Detweiller, as well as the development of a river front park and garden in conjunction with the City and the Private sector, as well as a shoreline golf course and other park and open space opportunities, are available for public access. The Peoria Park District, in conjunction with the City of Peoria and the Detweiller Trust as well as the DOC are working together in the development of a hiking/jogging/biking trail now in the initial stage of construction. This trail, envisioned to be a connecting link between the existing Rock Island trail and East Peoria, Morton and Pekin has become a reality. The Peoria side of the trail has a potential length of 48 miles. This planned trail will parallel the river corridor for a portion of its length due to local governmental efforts in acquiring the former railroad switching yards and other riverfront lands previously owned or leased to the private sector. (See also W91-03608) (Lantz-PTT)
W91-03612

UPDATE OF TRI-COUNTY RIVERFRONT PLAN.
Scruggs and Hammond, Inc., East Peoria, IL.
L. D. Luebbe.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 91-95.

Descriptors: *Illinois, *Resources management, *Urban areas, *Water resources management, Land use, Long-term planning, Peoria, Recreation, Water resources development.

Several progress observations are presented comparing present development and public interest with those of 20 years ago. The area of public interest has grown significantly since 1968. Today considerable public access facilities have been created through land acquired or transferred for recreational use. River Basin development is now of greater concern, as well as floodplain zoning. In 1968, tributary erosion control was emphasized by keeping channel tributaries clear of vegetation. Today there are programs to revegetate streambanks to prevent erosion, thereby helping to prevent the loss of farmland. The development of a regional bikeway and jogging trail connecting the communities of Pekin, East Peoria and Peoria is now in varying stages of construction. It is believed that such a project will provide greater exposure of the waterfront to the citizenry. (See also W91-03608) (Lantz-PTT)
W91-03620

ILLINOIS RIVER AND PEORIA LAKES: IT'S TIME TO ACT.
Caterpillar Tractor Co., Peoria, IL.
M. Reuter, H. W. Holling, and R. W. Frazee.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 99-105.

Descriptors: *Erosion control, *Illinois, *Illinois River, *Peoria Lakes, *Water resources management, Dredging, Economic aspects, Lake sediments, Management planning, Public policy, Sedimentation, Watershed management.

In June 1988, the Heartland Water Resources Council of Central Illinois (HWRCI) was formed to manage the issue of saving the Illinois River and Peoria Lakes from sedimentation. A number of studies have documented the river's loss of volume (77% since 1903) and other changes. The HWRCI is attempting to build an awareness of the sedimentation problem and broaden the base of support for the challenge to keep soil on the land and manage the sediment already in the Illinois River and Peoria Lakes. Causes are varied, but the two critical sources of erosion mentioned include crop land which slopes less than 5%, and streambanks. The solution presented is multidimensional but not conclusive: selective dredging, construction of Islands for a sediment depository and improved wildlife habitat, and enhanced erosion controls on streambanks and farmlands. Some of these projects could begin within two years and may cost close to $200 million. (See also W91-03608) (Lantz-PTT)
W91-03621

STREAM BANK STABILIZATION AND THE ILLINOIS RIVER SOIL CONSERVATION TASK FORCE.
Illinois River Soil Conservation Task Force, Eureka, IL.
For primary bibliographic entry see Field 4D.
W91-03623

PLANNING FOR THE FUTURE OF NAVIGATION ON THE ILLINOIS WATERWAY.
Army Engineer District, Rock Island, IL.
C. R. Smith, P. D. Soyke, and M. A . Cockerill.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 160-167, 1 tab, 4 ref.

Descriptors: *Illinois, *Illinois River, *Management planning, *Navigation, *Water resources management, Public participation, Public policy.

Selected management challenges and potential solutions to assure the future of the Illinois Waterway System are addressed, with emphasis placed on the role of the US Army Corps of Engineers within the context of a three-point management approach for executing navigation responsibilities. The existing condition is described, primarily in economic and environmental terms, and key issues and objectives are identified. The future will be approached within a strategic planning framework which integrates the concerns of all levels of government, the public and the numerous organizations and constituencies who share jurisdictions or interests on the Illinois Waterway System. In order to accomplish the studies, the Corps will begin to collect, compile, and evaluate the engineering, economic, and environmental data necessary to make sound management decisions. The reconnaissance study is scheduled to begin in November 1989, and, depending upon funding availability, is scheduled to be completed in April of 1991, at an estimated cost of $400,000. Federal and non-federal partners recognize that physical, economic, social, and commercial, and environmental conditions and needs have evolved since the Illinois Waterway was placed into operation in 1933 as a 90-ft channel project. Capacity, safety, operational efficiency, cost-effectiveness, and environmental compatibility issues must remain at the forefront of current capital investment planning and decision making. (See also W91-03608) (Author's abstract)
W91-03629

ILLINOIS RIVER AND THE U.S. CORP OF ENGINEERS.
Army Engineer District, Rock Island, IL.
J. R. Brown.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 175-180.

Descriptors: *Illinois, *Illinois River, *Mississippi River, *Water resources management, Environmental protection, Long-term planning, Monitoring, Navigation, Recreation, River systems, Upper Mississippi River Environmental Ma, Water quality.

The Illinois River and its tributaries, as a part of the Upper Mississippi River System, is a nationally recognized commercial and recreational boating navigation system with a complex ecosystem which needs to be protected. As such, the Illinois Waterway is a part of the Upper Mississippi River Environmental Management Program (UMR-EMP). The UMR-EMP is a unique project implemented by the Corp in cooperation with interagency groups including: the Fish and Wildlife Interagency Committee (FWIC); the River Resources Coordinating Team (RRCT); the On-Site Inspection Team (OSIT); and the River Industry Action Committee (RIAC). The project has no definitive cost-benefit ratio requirement. The EMP resulted from the GREAT River Studies begun in the 1972 to deal with the problems of sedimentation and dredged material placement. The EMP consists of five basic program elements: Habitat Rehabilitation and Enhancement Projects, Long-Term Resource Monitoring, Study of Impact of Recreation, Traffic Monitoring Study, and Recreation Projects. The Corp recognizes that the navigation pools, side channels, and backwaters of the Illinois Waterway are components of its complex ecosystem, and our Habitat Rehabilitation projects undertaken on a cost sharing basis with other Federal and State agencies will help provide nesting, food, and cover for fish and wildlife. (See also W91-03608) (Lantz-PTT)
W91-03632

TANK IRRIGATION IN SEMI-ARID TROPICAL INDIA: ECONOMIC EVALUATION AND ALTERNATIVES FOR IMPROVEMENT.
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).
For primary bibliographic entry see Field 3F.
W91-03648

EFFICIENT USE OF WATER IN IRRIGATION: PRINCIPLES AND PRACTICES FOR IMPROVING IRRIGATION IN ARID AND SEMIARID REGIONS.
Massachusetts Univ., Amherst. Dept. of Plant and Soil Sciences.
For primary bibliographic entry see Field 3F.
W91-03651

MANAGING CANAL IRRIGATION: PRACTICAL ANALYSIS FROM SOUTH ASIA.
Sussex Univ., Brighton (England). Inst. of Development Studies.
For primary bibliographic entry see Field 3F.
W91-03655

IMPACT OF RISK AND PLANNING HORIZONS ON THE SELECTION OF SOIL CONSERVATION MANAGEMENT SYSTEMS.
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 4D.
W91-03716

DEVELOPMENT OF AN INTERDISCIPLINARY PLANNING MODEL FOR WATER AND FISHERY MANAGEMENT.
New Mexico State Univ., Las Cruces. Dept. of Fishery and Wildlife Sciences.
R. A. Cole, F. A. Ward, T. J. Ward, and R. M. Wilson.
Water Resources Bulletin WARBAQ, Vol. 26, No. 4, p 597-609, August 1990. 9 fig, 2 tab, 13 ref.

Descriptors: *Computer models, *Fish management, *Lake fisheries, *Limnology, *Management planning, *Model studies, *Primary productivity, *Reservoir fisheries, *Water resources management, Biomass, Fish conservation, Licensing, Mathematical models, Nutrients, Sport fishing.

An interdisciplinary model was developed that analyzes the effects of resource management decisions on New Mexico fishery production, yield, sportfishing effort and economic benefit to anglers. The model recreates river flows and materials transported through reservoirs and their tailwaters from 1974 through 1987. Solar radiation, water temperature, phosphorus, nitrogen, suspended solids, and water exchange rates determine primary production. Organic loads from watershed sources, added to primary production, form a trophic base for sportfish forage. Fish production is partitioned into biomass and growth of each age class in sportfish and forage fish groups by differential responses to food type, light, water level fluctuation and predation. Fish biomass, with angler population distribution and site condition, contributes to determining angler effort and economic benefits. Model users can vary and analyze water level and quality, stocking, fishing regulations, site access, site facilities, and site entry fees. The model (on floppy disks with a user manual) is available for operation on MS DOS compatible computers with a hard disk. (Author's abstract)
W91-03855

ENVIRONMENTAL IMPACT ASSESSMENT IN THE PEOPLE'S REPUBLIC OF CHINA.
Wisconsin Univ.-Green Bay. Coll. of Environmental Sciences.
For primary bibliographic entry see Field 6E.
W91-03874

INTEGRATING FORAGE, WILDLIFE, WATER, AND FISH PROJECTIONS WITH TIMBER PROJECTIONS AT THE REGIONAL LEVEL: A CASE STUDY IN SOUTHERN UNITED STATES.
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
For primary bibliographic entry see Field 4C.
W91-03877

6B. Evaluation Process

WATER-RESOURCES PROGRAMS AND HYDROLOGIC-INFORMATION NEEDS, MARION COUNTY, INDIANA, 1987.
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 6A.
W91-02967

DEVELOPMENT OF DECISION AIDS.
D. J. Lawrence.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 25-27.

Descriptors: *Agriculture, *Conservation, *Decision making, *Information exchange, *Nonpoint pollution sources, *Soil conservation, *Water conservation, *Water pollution control, *Water quality control, Computer programs, Databases, Information systems, Land use, Resources management.

The role of the Soil Conservation Service (SCS) has, and continues to be, assisting farmers and ranchers with making decisions about soil and water conservation. SCS has initiated several efforts to bring conservation planning procedures in line with current agricultural realities. To meet the decision maker's demand for more quantified information, SCS undertook an assessment of the tools (computer programs, procedures, worksheets, etc.) available for estimating the effects of conservation on a broad range of resources, including: soil, water, air, plant, animal, and human. Delivering information to SCS field staffs is a key link between the research community and landusers; application of expert systems in delivery of new technology needs to be assessed. The interdisciplinary assessment group recommended many development needs, including conservation practice and effects on water quality, plant ability to cycle nutrients and pesticides, fate of water and chemicals in the vadose zone, sediment yield procedures for fields and watersheds, economic effects of water quality, and evaluation of current water quality conditions. The development of new decision aids for a broad range of resource concerns needs to be undertaken immediately. Although the most difficult software and database developmental issue can be that of identifying a project slate, the Tools Assessment and Development Report provides the agency with a subjective guide to developing decision aids, and therefore it can assist in the allocation of limited software development funds. The development of these new decision aids will require increased awareness of producer information needs; improved partnerships with the research community; and innovative ways of transferring the new conservation effects information. (See also W91-02985) (Fish-PTT)
W91-02991

POLICY ANALYSIS, AGRICULTURE, AND WATER QUALITY.
For primary bibliographic entry see Field 5G.
W91-02995

EPA'S CEEPES PROJECT: DESCRIPTION AND DATA NEEDS.
For primary bibliographic entry see Field 5G.
W91-02997

ANALYZING NATIONAL FARM CONSERVATION POLICY IN A NATIONAL GIS.
Center for Resource Innovations, Washington, DC.
M. S. Maizel, and K. Chan.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 91-94, 6 ref.

Descriptors: *Agriculture, *Conservation, *Farm management, *Geographic information systems, *Nonpoint pollution sources, *Resources development, *Water pollution control, Databases, Environmental policy, Government supports, Groundwater pollution, Management planning.

The Conservation Title of the 1985 Farm Bill together with proposals for the 1990 Farm Bill promise wider interest on the part of Congress in conservation policies to protect the nation's agricultural and related natural resources. The need to assess current provisions comprehensively and design new approaches to the sustainability of farm and farm-dependent resources is thus also a growing concern. The idea of 'targeting' resource regions using geographic information systems (GIS) with special policy provisions is a potential option. The Center for Resource Innovations together with the Harvard Laboratory for Computer Graphics and Spatial Analysis has been analyzing proposals for the 1990 Farm Bill which might lead to ground and surface water resources protection, enhancement and protection of endangered species and other wildlife habitats and other ecologically sensitive resources. The National Resources Inventory (NRI) of the Soil Conservation Service, U.S. Department of Agriculture is periodically-conducted assessment of the status, use, and potential of 1.5 billion of the nation's nonfederal rural lands. To these databases, EPA's REACH FILE has been overlaid to draw relationships between the NRI polygons on a watershed basis. This database has been used to assess the potential for multiple benefits of the Conservation Title of the 1985 Farm Bill and to assess the potential for groundwater and surface water contamination from farm practices. More and better geological information is needed, as well as finer delineation of specific climate, cropping systems, cover and practices and other information are needed for cause/effect analyses for groundwater vulnerability. (See also W91-02985) (Fish-PTT)
W91-03003

C AND SF PROJECT: ADAPTING A WATER RESOURCES PROJECT TO CHANGING PRIORITIES.
Army Engineer District, Jacksonville, FL.
S. J. Appelbaum.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 2A-13--2A-20, 9 ref.

Descriptors: *Central and Southern Florida Project, *Flood control, *Florida, *Management planning, *Regulated flow, *Water management, *Water resources management, Evaluation, Kissimmee Lake, Kissimmee River, Lake Okeechobee, Public policy, Water quality.

The Central and Southern Florida (C and SF) Project was conceived in 1947 by the US Corp of Engineers to provide flood protection and water control for central and southern Florida. While many of the project works have been constructed, development of the project continues today. Conditions and water resources priorities in the area are vastly different today. Population growth in central and south Florida has increased tremendously in the past 40 years. Awareness and understanding of the complex and fragile ecosystem of central and southern Florida have also increased in the years since the project was originally formulated, although Federal planning procedures for water resources projects and fiscal constraints have sometimes impeded this process. As part of the C and SF project, the upper Kissimmee lakes were regulated and the lower Kissimmee River was channelized. Restoration of the Kissimmee has been proposed as one of the strategies to improve water quality of Lake Okeechobee. (See also W91-03032) (Lantz-PTT)
W91-03035

INCREASING THE VALUE OF TECHNICAL DATA FOR MAKING GROUNDWATER POLICY DECISIONS.
North Carolina State Univ., Raleigh. Dept. of Economics.
For primary bibliographic entry see Field 7B.
W91-03075

AMERICAN RIVER AND AUBURN DAM: AN EXAMPLE OF THE NEW WATER POLICY.
California State Univ., Sacramento. Dept. of Economics.
For primary bibliographic entry see Field 6A.
W91-03079

EVALUATING THE IMPLEMENTATION AND EFFECTIVENESS OF BASIN PLANS IN KING COUNTY, WASHINGTON.
King County Surface Water Management Div., Seattle, WA.
D. Hendrickson.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 14B-1--14B-14, 7 tab.

Descriptors: *King County, *Performance evaluation, *Surface water, *Washington, *Water resources management, Compliance, Evaluation, Water management, Water plans, Watershed management.

In 1987, King County, Washington evaluated the implementation and effectiveness of five major comprehensive watershed plans completed over the previous decade. The project had two major findings. First, most of the recommendations in the plans have not been implemented. The percentage of all recommended solutions, structural and nonstructural, that have been implemented, ranges from 17% ten years after plan completion to 36% after 6 years. The reasons identified for poor implementation include: insufficient funding and staff; no established implementation procedures; unclear recommendations; and unassigned responsibility for implementation. Second, some of the solutions that were implemented have not performed as predicted. Reasons for this include: inaccurate or outdated design assumptions; insufficient maintenance of structural solutions; and poor enforcement of regulatory solutions. The project recommended numerous improvements in King County's new Surface Water Management Program to correct these past problems. Recommendations addressed four general themes: (1) basin plans should be living documents that can be routinely modified in response to new information or changed conditions; (2) specific staff should be accountable for plan implementation; (3) institutional changes are needed to ensure better regulatory compliance; and (4) budget and scheduling decisions should not compromise the quality of plan analyses. (See also W91-03032) (Author's abstract)
W91-03093

APPROPRIATE METHODOLOGIES FOR DEVELOPMENT AND MANAGEMENT OF GROUNDWATER RESOURCES IN DEVELOPING COUNTRIES. VOLUME III.
For primary bibliographic entry see Field 2F.
W91-03178

SECONDARY ECONOMIC IMPACT OF ACID DEPOSITION CONTROL LEGISLATION IN SIX COAL PRODUCING STATES.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5G.
W91-03220

COST AND TECHNOLOGY DOCUMENT ON DRINKING WATER TREATMENT FOR LOW RANGE COSTS: ESTIMATED LOW RANGE COSTS FOR THE REMOVAL OF INORGANICS, RADIONUCLIDES, AND CORROSION RELATED CONTAMINANTS FROM POTABLE WATER SUPPLIES.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
For primary bibliographic entry see Field 5F.
W91-03221

1988 NEEDS SURVEY REPORT TO CONGRESS: ASSESSMENT OF NEEDED PUBLICLY OWNED WASTEWATER TREATMENT FACILITIES IN THE UNITED STATES.
Environmental Protection Agency, Washington,

DC. Office of Municipal Pollution Control.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-189633. Price codes: A03 in paper copy, A01 in microfiche. Report no. 430/09-89-001, February 1989. 70 p, 6 fig, 4 tab, 4 append. Contract no. 68-03-3476.

Descriptors: *Capital costs, *Clean Water Act, *Economic evaluation, *Municipal wastewater, *Wastewater facilities, Cost analysis, Participating funds, Public health, Secondary wastewater treatment, Sewer systems, Water quality.

The Environmental Protection Agency (EPA) has compiled a detailed estimate of the capital costs to build publicly owned municipal wastewater treatment facilities to comply with the requirements of the Clean Water Act. The 1988 Needs Survey focuses on construction grant eligible category of need, rather than the expanded State Revolving Fund eligibilities under the 1987 Amendments to the Clean Water Act. EPA's needs estimates include those for which a water quality or public health problem could be documented in accordance with specific criteria established in the 1986 Survey. The needs for documented facilities are: $83.5 billion to satisfy all categories of need for the design year (2008) population, and $67.9 billion to satisfy all categories of need for the current (1988) population. Compared to previous Surveys, the overall change is small which suggests that grant-eligible needs are beginning to stabilize. A total of 15,591 treatment facilities are operating in 1988, and 17,374 facilities will be in operation when all documented needs are met. Eighty-eight percent of existing treatment facilities currently provide secondary treatment or better. When design year needs are met, nearly all treatment facilities will provide secondary treatment or better. Over 1,100 collection systems have combined sewer systems. Of these, 328 have documented needs in the 1988 Survey, totaling $16.4 billion to correct combined sewer overflow problems. (Fish-PTT)
W91-03232

LONG-TERM EVALUATION OF WETLAND CREATION PROJECTS.
Hampshire Coll., Amherst, MA. School of Natural Science.
For primary bibliographic entry see Field 2H.
W91-03267

OPTIONS TO BE CONSIDERED IN PREPARATION AND EVALUATION OF MITIGATION PLANS.
Environmental Protection Agency, Atlanta, GA. Region IV.
W. L. Kruczynski.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 555-570, 1 fig, 1 tab, 3 ref.

Descriptors: *Alternative planning, *Artificial wetlands, *Water resources management, *Wetland restoration, *Wetlands, Compensation, Environmental engineering, Environmental impact, Evaluation, Monitoring, Project planning, Water law, Water resources development.

Consideration of compensatory mitigation should be confined to projects which comply with the Environmental Protection Agency's Section 404(b)(1) Guidelines. The complexity of designing a successful mitigation plan is due to specific characteristics of many types of wetlands and the many options available at mitigation sites. The types of compensatory mitigation, in order of preference, are: restoration, creation, enhancement, exchange. Preservation should only be considered when the ecological benefits of preservation greatly outweigh the environmental losses of an unavoidable filling activity. A methodology based upon rating of the options has been developed to aid in the selection of an acceptable mitigation plan. In general, on-site, in-kind, up-front mitigation is the preferred option. However, other options may be acceptable based on availability of sites, plant material, and other variables. The proposed methodology should be used as a guide and not as the only criterion in decision making. Monitoring of mitigation sites is essential to demonstrate creation of functional wetland systems. The specific issues which should be explicitly addressed during the permit review process to improve the prospects of successful compensatory mitigation of wetland losses for projects which otherwise comply with the Section 404 Guidelines are: slopes and gradients, soils, plant material, hydrology, monitoring, timing, location, and community type. (See also W91-03244) (Author's abstract)
W91-03272

HOW TO GET THE PUBLIC BEHIND WATER RECLAMATION.
Los Angeles County Sanitation District, CA.
J. Haworth.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 81-87.

Descriptors: *Public opinion, *Reclaimed water, *Wastewater treatment, *Water reuse, *Water shortage, *Water treatment, Economic aspects, Marketing, Public policy, Water resources management.

The public is very interested in water reclamation but is equally concerned about the risks. Since Los Angeles County is located in a semiarid desert there will always be a water shortage here. The public is aware that they are in a dry area. They are aware that they need water and they want their local water agency to supply it. To ensure public acceptance it is necessary to run a clean and open organization. Violations must be minimized. Spilled sewage is not helpful to the image of an agency that is supposed to be producing safe, reliable, reclaimed water. Seemingly peripheral things like odor are not helpful. The industry must present a classy face and a classy image for the public to see, in everything that is done including brochures and annual reports. It is important to be visible and available, especially when there is a problem. In good times take advantage of the lull in the bad times. Unfortunately, newspapers do not come out with headlines that read, 'Sewage Treatment Plant Ran Swell Yesterday'. The public will never know that a plant is running well unless someone tells them. With water reclamation there is a need for marketing. Wastewater agencies need allies who know what the agencies do, understand it, and think it is good. The worst ally is an uninformed ally. To develop informed allies it is necessary to spread accurate information. This can be done through tours, presentations, school programs and career days. In conclusion it is important for agencies to have good communication with the public, to build informed citizen allies, and to have credibility. (See also W91-03273) (Agostine-PTT)
W91-03283

WATER REUSE PLANS AND ASSISTANCE PROGRAMS.
San Diego County Water Authority, CA.
P. M. MacLaggan.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 107-117. 5 fig.

Descriptors: *California, *Financing, *Planning, *Reclaimed water, *Wastewater treatment, *Water resources institutes, *Water resources management, *Water reuse, *Water treatment, Economic aspects, Legal aspects, Management planning, Regulations.

The first step in the planning of water reuse programs is to establish a regional coordinator. The water authority acts as the regional coordinator in San Diego County. The next step, which brings together all the key players, is the formation of a reclamation advisory committee. In San Diego County the Water Authority Reclamation Advisory Committee (WARAC) is comprised of representatives from each entity and meets monthly. WARAC is subdivided into committees that are looking at water reuse activities on a drainage basin-wide basis. Additionally, there is a subcommittee looking at policy and financing issues. All reclamation matters are passed through the WARAC to the Water Authority Board of Directors for consideration. Probably the most important step in developing a regional water reuse program is to look at local issues related to institutional relationships, project implementation, operation, financing, pricing, and revenue distribution. In addition to institutional arrangements there is the need for regulatory support. Political support is also an important aspect of reclamation planning. It is necessary to have the support of federal, state, and local politicians for programs to go forward. Funding can come in three steps: planning, design, and construction. At the planning level the water authority of San Diego County provides under its Water Reclamation Technical Assistance Program, 50 percent of the planning funding when matched by the local participant. There are two existing financial mechanisms available for the design and construction funds. There is also a program for funding during the operational phase which has been established by the Metropolitan Water District of southern California. A model reclamation ordinance is being prepared which is expected to be adopted throughout the region. The ordinance will provide master planning in each of the agencies, mandatory use requirements, dual piping provisions, and elimination of brine discharges from home water softeners. (See also W91-03273) (Agostine-PTT)
W91-03286

COOPERATIVE AGREEMENT ON SETTLEMENT AND RESOURCE SYSTEMS ANALYSIS. PROCEEDINGS TO THE CONFERENCE ON THE AFRICAN EXPERIENCE WITH RIVER BASIN DEVELOPMENT: ACHIEVEMENTS TO DATE, THE ROLE OF INSTITUTIONS, AND STRATEGIES FOR THE FUTURE. HELD IN EASTON, MARYLAND ON MAY 24-27, 1988.
Clark Univ., Worcester, MA.
R. Perritt.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-105628/AS. Price codes: AO3 in paper copy, AO1 in microfiche. Report No. AID-PN-ABB-954. May 1988. 46p. SARSA Cooperative Agreement No. DAN-1135-A-00-4068-00. Prepared in cooperation with Institute for Development Anthropology, Binghamton, NY.

Descriptors: *Africa, *River basin development, *Water resources development, *Water resources management, *Watershed management, International commissions, Planning.

Guidelines for improved river basin planning were developed at a conference of more than 50 international specialists. Participants reviewed achievements and problems of river basin development to date and proposed future strategies. A major theme of the conference was the importance of defining a planning process appropriate for the unique characteristics of African river basins. The conference supported environmentally sound water controls that can interact with local systems, such as surface and groundwater storage. The report also summarizes workshop recommendations on the following issues: the strengths and weaknesses of regional river basin institutions; the role of local organizations; the need for trained personnel; and the importance of research to improve river basin development. The report includes a French summary of the conference proceedings. (Author's abstract)
W91-03585

GREAT LAKES: LIVING WITH NORTH AMERICA'S INLAND WATERS.
For primary bibliographic entry see Field 2H.
W91-03672

GREAT LAKES INSTITUTIONS AND THE POLICY PROCESS: ISSUES IN INTERSTATE AND INTERNATIONAL RESOURCE MANAGEMENT.
Great Lakes Commission, Ann Arbor, MI.

M. J. Donahue.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 1-10, 17 ref.

Descriptors: *Great Lakes, *Lake management, *Regional planning, *Water policy, *Water resources management, Canada, Governmental interrelations, Lake basins, Policy making, Political aspects, Water pollution control, Water quality management, Watershed management.

As a shared, multi-purpose resource, the Great Lakes are extensively used and managed at every level from municipalities to the international arena. A complex array of federal, state, provincial, local, and regional entities collectively defines the Great Lakes 'institutional ecosystem.' An understanding of the various roles, responsibilities and interrelationships within this 'ecosystem' is critical to sound policy development. Major uses of the Great Lakes include water supply, industry, transportation, recreation and tourism, power production, commercial and sport fishery, and waterfront development. Regional organizations play a pivotal role in Great Lakes Basin management by coordinating all other levels of government, and there are a multitude of issues that defy solution by political jurisdiction and must therefore be addressed in regional forum, such as water quality (point source pollution, nonpoint source pollution, in-place pollutants, airborne pollutants, and landfill and groundwater pollution), hazardous water management, fish contamination, and lake water levels. The Great Lakes deserve stature as a global laboratory for scientific inquiry and institutional analysis. In essence, the Great Lakes region is a composite of the whole array of socioeconomic, political, and environmental characteristics and issues that one might find in any water-based region, it is advisable to focus future research and policy attention to comparative analyses and technical exchange between various regions. (See also W91-03672) (Fish-PTT)
W91-03673

GREAT LAKES RESEARCH NEEDS AND HOW TO MEET THEM.
Michigan Dept. of Natural Resources, Lansing. Office of the Great Lakes.
K. E. Vigmostad, T. Anderson, and T. D. Martin.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 11-20, 2 ref.

Descriptors: *Environmental policy, *Great Lakes, *Hydrologic data, *Lake management, *Research, *Research priorities, *Water policy, *Water resources management, Canada, Ecosystems, Freshwater, Habitats, Natural resources, Surveys, Water quality management.

The Laurentian Great Lakes form the largest freshwater lake system in the world. These Lakes hold 95% of the nation's surface freshwater reserves and 20% of the world's. The Lakes contribute directly to the ecological and socioeconomic wellbeing of 37 million basin residents. Pressing water quality and quantity problems point to the gaps in research and information upon which to base sound public policy decisions. From a frontline, state-agency perspective, sound management depends on solid information about the Lakes, which requires quality research. Furthermore, ecosystem management demands ecosystem-oriented research. Based on the findings of a 75-member international team and an Office of the Great Lakes survey of universities and colleges, foundations, private nonprofit organizations, and state agencies, it is indicated that basic Great Lakes research needs include: sediment cores, budgets for the basic life chemicals, interactions between lake physics, food webs, and biological productivity. Specific jurisdictional research areas were identified as: chemical transport and fate; continental and global processes; critical habitat protection and resource inventory; ecological processes and population dynamics; health of Great Lakes fish and birds; human health impact of toxicants; institutional arrangements and facilities; monitoring; open lake and shoreline physical processes; social, economic, and political issues; water levels; and water quality. By providing adequate, protected sources of funding and by coordinating research activities into a common effort, a research climate can be developed which fosters and enables cutting-edge, ecosystem-oriented research of value to all of the large lakes of the world. (See also W91-03672) (Fish-PTT)
W91-03674

REMEDIAL ACTION PLANS: A GREAT LAKES PROGRAM WHOSE TIME HAS COME.
International Joint Commission-United States and Canada, Windsor (Ontario).
J. H. Hartig.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 45-51, 1 fig, 1 tab, 7 ref.

Descriptors: *Great Lakes, *Lake management, *Lake restoration, *Water policy, *Water pollution control, *Water resources management, Canada, Environmental impact, Environmental policy, Evaluation, Governmental interrelations, Management planning, Ontario, Political aspects, Public participation, Site remediation.

Forty-two Areas of Concern have been identified in the Great Lakes Ecosystem where general or specific objectives of the Great Lakes Water Quality Agreement are not met and such failure has caused or is likely to cause impairment of beneficial use or of the area's ability to support aquatic life. Although some Areas of Concern still exhibit bacterial pollution and eutrophication, the major problem here today is toxic substances contamination (e.g., 41 of the 42 Areas of Concern have toxic substances contamination). In 1985, the eight Great Lakes states and the province of Ontario committed themselves to developing a remedial action plan (RAP) to restore beneficial uses in each Area of Concern within their political boundaries. RAPs must not only identify specific measures necessary to control existing sources of pollution, abate environmental contamination (e.g., contaminated sediments) and restore beneficial uses, but must present timetables for implementation of remedial actions to be able to measure progress. Three primary reasons why this RAP program is different from previous initiatives include: public participation (commitment to generate and sustain broad community support); strategic planning (identifying when specific actions will be taken in the future to resolve the problems); and evaluating and tracking progress (IJC) will evaluate RAPs for adequacy and biennially track implementation progress). (See also W91-03672) (Author's abstract)
W91-03677

LAKE SUPERIOR'S HIGH WATER LEVEL AND DAMAGES: A DELICATE BALANCE.
Minnesota Dept. of Natural Resources, St. Paul.
O. Sium, P. Otterson, and D. Retka.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 111-115, 1 fig, 1 tab, 5 ref.

Descriptors: *Great Lakes, *Lake Superior, *Lake management, *Minnesota, *Water level fluctuations, *Water resources management, Erosion, Flood damage, Interagency cooperation, Lake shores, Land use, Management planning, Shore protection, Zoning.

Minnesota's Northshore damage survey was done as a result of the high water levels in Lake Superior during 1985-1986. Massive erosion and structural damages began to occur when Lake Superior's water level exceeded elevation 602.2 feet International Great Lakes Datum 1955. Damages due to the 1985-1986 period were estimated at about $77 million in Minnesota. Shoreland development, shipping, and recreational activities have been consistent with the International Joint Commission's operating plan to manage Lake Superior's water levels between elevations 600.5 and 602.0. Because Minnesota's Northshore is a unique resource, the Northshore Management Board, consisting if representatives of each unit of government along the Shore with the exception of Duluth, was formed to develop a land use management plan for the North Shore. The plan will be the basis for the adoption of improved local zoning controls which will conserve natural resources, protect water quality and lessen damage to future development due to flooding, wave action, seepage, and erosion. (See also W91-03672) (Author's abstract)
W91-03684

REVIEW OF PUBLIC PARTICIPATION IN THE GREAT LAKES WATER QUALITY AGREEMENT.
League of Women Voters of Michigan, Brighton.
C. Y. Swinehart.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 137-147, 19 ref.

Descriptors: *Great Lakes, *International commissions, *Lake management, *Public participation, *Water quality management, *Water resources management, Canada, Governmental interrelations, Management planning, United States, Water resources development.

The Great Lakes Water Quality Agreement expresses the commitment of the U.S. and Canada to improve and preserve the quality of the world's largest fresh water ecosystem: the Great Lakes-St. Lawrence River. Despite considerable obstacles of distance, expense, different political/legal systems and culture, citizens of both countries have played an ongoing and increasingly significant part in the development, implementation, and improvement of the agreement. Public involvement has evolved from citizen's demands for international studies that resulted in the original binational commitment of 1972, through their increasingly active monitoring of agreement implementation, to the participation of public interest groups in the governments' 1987 review and modification of the 1987 review and modification of the 1978 agreement. Some options for future participation include: creation of a citizen advisory committee for the International Joint Commission (IJC); citizen appointments to the agreement's boards and committees; full participation in the development, monitoring, and implementation of remedial action plans for Great Lakes areas of concern; more direct and public communication in IJC biennial meetings on Great Lakes water quality; greater outreach by governments and the IJC to citizens in future reviews and negotiations of agreements. The acceptance and implementation of these and other opportunities depends on the imagination, initiative, and willingness of citizens, the U.S. and Canadian governments and the IJC. (See also W91-03672) (Fish-PTT)
W91-03687

MANAGEMENT APPROACHES WITHIN THE 1987 US/CANADA GREAT LAKES WATER QUALITY AGREEMENT.
Environmental Protection Agency, Chicago, IL. Great Lakes National Program Office.
K. Fuller.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 149-153.

Descriptors: *Environmental protection, *Governmental interrelations, *Great Lakes, *Lake management, *Water quality management, *Water resources management, Canada, Clean Water Act, Ecosystems, Interagency cooperation, International commissions, United States, Water pollution management, Water quality standards.

Two major events occurred during 1987 that will change management approaches to environmental quality in the Great Lakes. Section 118 of the Clean Water Act now specifically recognizes the U.S./Canada Agreement and sets its purpose, 'to achieve goals embodied in the Great Lakes Water Quality Agreement.' The second event was the

signing of amendments to the Agreement by the U.S. and Canada following a year-long review. The new management themes provided by the amendment consist of five elements: (1) accountability for taking action has been strengthened by calling for reports by specific dates and clarified in terms of the responsibilities of the federal governments, states, and the International Joint Commission; (2) a process is specified for sorting out the hundreds of chemicals of concern in the Lakes for the purpose of setting ambient objectives (criteria); (3) the two countries are to consult at least every two years to establish or modify ambient objectives, including ecosystem objectives; (4) the remedial action plans are called for to address designated geographic 'areas of concern'--hard core polluted areas where beneficial uses have not yet been fully restored; and (5) Lake Management Plans are called for to address 'critical pollutants,' to be designated by the federal governments. These new provisions will allow all concerned to understand the problems and keep score on progress being made. (See also W91-03672) (Author's abstract)
W91-03688

SIGNIFICANCE OF GIS AND REMOTE SENSING TECHNOLOGY IN GREAT LAKES MONITORING AND RESOURCE MANAGEMENT.
Wisconsin Univ.-Madison. Environmental Remote Sensing Center.
For primary bibliographic entry see Field 7B.
W91-03689

GROUND WATER RECHARGE: DEMONSTRATION PROGRAM AND POLICY ISSUES.
Bureau of Reclamation, Denver, CO.
B. P. Glenn.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 123-131, 1 fig.

Descriptors: *Artificial recharge, *Demonstration programs, *Groundwater management, *Groundwater recharge, *Nonpoint pollution sources, *Water policy, *Water resources management, Arizona, California, Colorado, Idaho, Interagency cooperation, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, Project planning, South Dakota, Texas, Utah, Washington, Water pollution control, Wyoming.

The High Plains States Groundwater Demonstration Program Act (Act) of 1983 directs the Secretary of the Interior, acting through the Bureau of Reclamation, to engage in a special study of the potential for groundwater recharge in the High Plains States (Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming) and other Reclamation Act States (Arizona, California, Idaho, Montana, Nevada, North Dakota, Oregon, Utah, and Washington). The Program is being carried out in two phases. Phase I was the planning, development, and site selection phase, and Phase II is the design, construction, operation, and evaluation phase. The legislation established a two-year period for Phase I and a five-year period for Phase II. The Phase II plan will contain not less than 21 demonstration sites, located in areas having a declining water table, an available surface water supply, and a high probability of physical, chemical, and economic feasibility for recharge of the groundwater reservoir. The program will emphasize recharge orientation, local supplies, nonstructural aspects, institutional and legal aspects, and uniqueness. Project proposals were submitted, evaluated, and selected based on technical merit, environmental clearance requirements, requirements of the Act, and cost ceiling constraints. Policy issues which will be addressed during the study include the identification of the beneficiaries of groundwater recharge, allocation of costs, and integration into existing Federal Projects. Groundwater protection is emerging as an important issue in the program. (See also W91-03704) (Fish-PTT)
W91-03718

CREATING SUCCESSFUL PROGRAMS: THE INNOVATIVE TOUCH.
Weston (Roy F.), Inc., Washington, DC.
For primary bibliographic entry see Field 5G.
W91-03720

BIRTH OF A MEGAPROJECT: POLITICAL ECONOMY OF FLOOD CONTROL IN BANGLADESH.
Massachusetts Univ., Amherst. Dept. of Economics.
For primary bibliographic entry see Field 4B.
W91-03873

IS BROADSCALE REVEGETATION ECONOMIC AND PRACTICAL AS A GROUNDWATER AND SALINITY MANAGEMENT TOOL IN THE MURRAY-DARLING BASIN.
La Trobe Univ., Bundoora (Australia). School of Agriculture.
For primary bibliographic entry see Field 4C.
W91-03895

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

ECONOMIC ANALYSIS OF PROPOSED AMENDMENTS TO WATER POLLUTION REGULATIONS PHOSPHORUS DISCHARGES R87-6.
Blaser, Zeni and Co., Springfield, IL.
For primary bibliographic entry see Field 5G.
W91-03022

ECONOMIC ANALYSIS OF PROPOSED SITE SPECIFIC CHANGES TO WATER QUALITY REGULATIONS AFFECTING BORDEN CHEMICAL COMPANY.
Booker Associates, Inc., St. Louis, MO.
For primary bibliographic entry see Field 5G.
W91-03023

TECHNOLOGIES AND COSTS FOR THE REMOVAL OF SYNTHETIC ORGANIC CHEMICALS FROM POTABLE WATER SUPPLIES.
Environmental Protection Agency, Washington, DC. Criteria and Standards Div.
For primary bibliographic entry see Field 5F.
W91-03029

COST SHARING: IT'S IMPACT ON WATER RESOURCES DEVELOPMENT.
Military Academy, West Point, NY. Dept. of Electrical Engineering.
G. E. Galloway.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 2A-1--2A-9, 2 fig, 2 tab, 14 ref.

Descriptors: *Cost sharing, *Water management, *Water resources development, Community development, Construction costs, Cost-benefit analysis, Costs, Feasibility studies, Federal jurisdiction, Local governments, Project planning.

The 1986 Water Resources Development Act, imposed on the water resources development programs of the US Army Corp of Engineers, increased requirements for local sponsors of water projects to share in the funding of both feasibility studies and project construction. This approach, on the drawing board for nearly ten years, was expected to significantly alter the pattern of water resources development. The first three years of experience under the Act are examined in this paper, as well as its predecessor activities not initiated because of a failure to obtain the needed cost sharing agreements. General conclusions are drawn concerning the possible long-term impacts of the fiscal driven criteria for project activity. Among the conclusions are: (1) limited funding through the Federal government for spending in the water resources arena go further when combined with contributions from local sponsors; (2) demonstrated willingness to pay by sponsors, for participation in planning and project construction, stands as evidence that the benefit cost ratio established for the project is in fact correct; and (3) the greater focus on insuring fiscal responsibility in project development is also improving the quality of management of these projects with attendant savings and benefits for the Federal government. (See also W91-03032) (Lantz-PTT)
W91-03034

MANAGING WATER RESOURCES BY INTEGRATING PLANNING: NEW JERSEY'S STATE PLAN.
New Jersey Dept. of the Treasury, Trenton. Office of State Planning.
R. A. Kull.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 1B-21--1B-33, 2 fig, 3 tab, 4 ref.

Descriptors: *Costs, *Management planning, *New Jersey, *Water management, *Water resources management, Classification, Economic aspects, Evaluation, Financial feasibility, Public policy, State jurisdiction, Water resources development.

Continued population and employment growth in New Jersey is approaching the existing capacity of water resources to sustain future development. Technological responses to enhance this capacity are available, but at substantial increases in public utility and service costs. The ability to finance these costs is limited; future development must be made more efficient to ensure optimum use of infrastructure and the protection of natural resources. The management of development, currently shared among numerous functional State agencies, general county and municipal governments, and special districts must be better coordinated. New Jersey's new State Planning Act provides a mechanism to integrate planning. A State Development and Redevelopment Plan now being prepared includes statewide policies for planning and development; a regional design system specifying a hierarchy of community types based on infrastructure and resource capacities; a 'tier' system classifying areas of the state based on common issue and characteristics; a 'cross-acceptance' process for refining the Plan prior to adoption, by building consensus across all levels of government; and a monitoring process to measure the Plan's effectiveness. (See also W91-03032) (Author's abstract)
W91-03038

COST OF WASTEWATER RECLAMATION.
HYA Consulting Engineers, Arcadia, CA.
M. G. Hoover.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 55-64. 5 tab, 6 ref.

Descriptors: *California, *Cost analysis, *Reclaimed water, *Wastewater treatment, *Water reuse, *Water treatment, Economic aspects, Irrigation, Waste disposal, Water resources management.

Wastewater can no longer be treated to a high level of purity for disposal and non-beneficial uses, such as deep ocean discharges. The beneficial use of reclaimed water as a water resource, particularly for irrigation, and the offsetting costs for importing, avoiding water system expansion, and developing wastewater disposal systems can make reclamation practical, economical, and efficient. The cost components of reclaimed water need not be complicated but should include the detail of a number of cost elements based upon reasonable assumptions. Using the example of costs from other agencies, particularly the Irvine Ranch Water District, it is evident that reclaimed water when viewed from the position of water resource management can be as asset with a favorable cost to benefit ratio. When considered a water source and compared to the avoided costs of imported water and expanded potable water systems, it becomes an even more attractive argument. In costing reclaimed water, consideration of the following is essential: (1) listing cost centers and elements; (2) consideration of funding sources; (3) adoption of a

pricing philosophy based on the market and the value of the reclaimed water; (4) involvement of the end users; (5) utilization of the experience and 'learning curve' of other agencies. Water reclamation is a program. The program includes a series of projects, public relations, education and training. It involves dedication and commitment. Implementation of water reclamation is an essential part of managing water resources. (See also W91-03273) (Author's abstract)
W91-03281

FINANCING RECLAMATION PROJECTS.
South Coast Water District, Laguna Beach, CA.
R. C. Miller.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 65-80.

Descriptors: *California, *Financing, *Reclaimed water, *Wastewater treatment, *Water reuse, *Water treatment, Economic aspects, Legal aspects, Legislation.

The basic provisions of the financing alternatives available to most public agencies is outlined. The discussion is general in nature and does not include all of the details involved in each of the financing options. The information is sufficient to make a conceptual decision on the approach to financing a given project. Once a decision is made, a financing consultant can provide the specifics on any proposed financing, including recommendations on timing, structure, term, call features, reserve funds, ratings, insurance provisions, and similar technical features. Among the options outlined are (1) Mello-Roos Community Facilities Act of 1982, (2) Special Assessment bond financing, (3) Improvement Act of 1911-Assessment Proceedings, (4) Improvement Act of 1911-Bonds, (5) Municipal Improvement Act of 1913, (6) Improvement Bond Act of 1915, (7) Revenue bonds, (8) General obligation bonds, (9) Lease-revenue securities, and (10) Short-term debt instruments. Floating rate securities are suggested as a way to reduce annual financing costs. A brief outline of municipal bond insurance is also given. (See also W91-03273) (Agostine-PTT)
W91-03282

WATER POLLUTION ABATEMENT EXPENDITURES IN THE WISCONSIN PAPER INDUSTRY.
Wisconsin Univ.-Madison.
For primary bibliographic entry see Field 5G.
W91-03589

EFFLUENT FEES: POLICY CONSIDERATIONS ON A SOURCE OF REVENUE FOR INFRASTRUCTURE FINANCING.
Yale Univ., New Haven, CT. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 5G.
W91-03592

REVENUE SOURCES FOR RIVER MANAGEMENT.
Illinois Univ., Urbana.
W. D. Seitz.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 139-144, 2 ref.

Descriptors: *Economic aspects, *Illinois, *Illinois River, *Rivers, *Taxes, *Water resources management, Financing, Licenses.

Traditional sources of revenue will not be adequate to implement land and water measures necessary to manage the Illinois River. An analysis of alternative sources of revenue and the approximate revenue potential, based on an earlier analysis of revenue sources for lake management, is presented. Recreational license surcharges, users fees for demarcated recreational sites, marine fuel taxes, excise taxes of recreational equipment, potable water surcharges, special tax assessments on property, and assessments on polluters, are among the alternatives explored. Some of these alternatives appear to be applicable at the local level, but may require special provisions such as the formation of a new management institution equivalent in this context to the special taxing district. State (or Federal) involvement is likely to be required to deal with the problems in major river systems such as Illinois. New institutional structures such as those developed to manage the Columbia River may merit attention. (See also W91-03608) (Author's abstract)
W91-03625

CROPPING STRATEGIES FOR EFFICIENT USE OF WATER AND NITROGEN: INTRODUCTION.
Georgia Agricultural Experiment Stations, Griffin.
For primary bibliographic entry see Field 3F.
W91-03634

MULTIPLE CROPPING FOR EFFICIENT USE OF WATER AND NITROGEN.
Georgia Coastal Plain Experiment Station, Tifton.
For primary bibliographic entry see Field 3F.
W91-03635

6D. Water Demand

WATER WITHDRAWAL AND USE IN MARYLAND, 1986.
Geological Survey, Towson, MD. Water Resources Div.
J. C. Wheeler.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 88-714, 1990. 30p, 7 fig, 12 tab, 23 ref, append.

Descriptors: *Maryland, *Pumpage, *Water use, Agricultural water, Aquaculture water, Domestic water, Hydroelectric power, Industrial water, Irrigation water, Mining water, Public water supply, Surface water, Thermoelectric power.

During 1986, about 1,460 million gallons per day of freshwater was withdrawn from the surface-, and groundwater resources of Maryland. In addition, more than 6,240 million gallons per day of saline surface water was withdrawn and used primarily for cooling purposes in the generation of electricity. Most freshwater withdrawals (84%) were from surface water sources and were withdrawn and used in the Potomac drainage basin, whereas most groundwater was withdrawn and used in the Upper Chesapeake drainage basin. The Potomac Group aquifers provided the most groundwater (56 million gallons per day). Ten water use categories comprise the major demands on the surface and groundwater resources of the State: public supply, domestic, commercial, industrial, mining, thermoelectric power generation, hydroelectric power generation, agricultural (non-irrigation), irrigation, and aquaculture. Public-supply systems withdrew the most water in the State (801 million gallon/day) for use by residents, commercial establishments, and industries. Baltimore City had the largest public-supply use in 1986 (about 151 million gallons/day). (USGS)
W91-02960

LESSONS LEARNED WHILE DEVELOPING PICS DATABASE.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 7C.
W91-03048

WATER USE REGULATION FOR THE '90'S - THE SOUTHWEST FLORIDA EXPERIENCE.
Southwest Florida Water Management District, Brooksville. Resource Regulation Dept.
K. A. Weber, and C. F. Harper.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 3B-1--3B-8, 1 fig, 11 ref.

Descriptors: *Florida, *Groundwater management, *Regulations, *Selective withdrawal, *Southwest Florida Water Management District, *Water law, *Water management, *Water use, Land use, Saline water intrusion, Water demand, Water resources development, Water resources management.

The State of Florida has one of the most comprehensive water management programs in the nation, with Water Management Districts encompassing the entire state. Each District is charged with a multitude of water management functions, including the regulation of water use. The Southwest Florida Water Management District (SWFMD) was the first in the state to regulate water withdrawals, in 1969. Recently the District has revised their water use rules with the aim of updating them based on an expanded knowledge of the District's hydrology, advances in technology, and the present and future demands imposed on the resource by the rapid growth of the region. These newly revised rules and procedures strike a balance between the optimum use of the water resources and their protection. These rules and procedures address the evaluation of reasonable water use, and withdrawal impacts on surface water bodies, wetlands, saltwater intrusion, inducement of pollution, existing water users and land use, and other water use problems. These rules were developed to manage limited water resources in the face of tremendous growth, and may serve as a model for other areas facing similar challenges. (See also W91-03032) (Author's abstract)
W91-03052

WATER USE PERMITTING IN FLORIDA: AN EFFECTIVE PROGRAM FOR ALLOCATING WATER.
Saint Johns River Water Management District, Palatka, FL. Dept. of Resource Management.
J. C. Elledge.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 4B-17--4B-28, 2 fig, 11 ref.

Descriptors: *Florida, *Groundwater management, *Regulations, *Water allocation, *Water districts, *Water management, *Water resources management, *Water use, Case studies, Consumptive Use Program, Potable water, St Johns River, Urbanization, Water demand.

Rapid growth in Florida has resulted in increased demands on natural resources, including surface and groundwater supplies. The significant increase in population has been concentrated in coastal areas which have limited local potable water supplies. As a result, 5 regional Water Management Water Districts, along with the Consumptive Use Permitting Program (CUP) have been established. The Districts were intended to be an administrative forum for the resolution of conflicts between competing users. The CUP program has several other goals: to ensure reasonable use of water; to protect the environment and the water supply; and to promote conservation. The CUP program has accomplished all of its established goals. Case studies are presented which focus on the effectiveness of the CUP program at the St. Johns River Water Management District. (See also W91-03032) (Lantz-PTT)
W91-03054

ECONOMIC EFFICIENCY AND INSTITUTIONAL CHANGE IN WATER ALLOCATION: THE 1987 HAWAII WATER CODE.
Hawaii Univ., Honolulu. Water Resources Research Center.
For primary bibliographic entry see Field 6E.
W91-03057

WATER-RESOURCES DEVELOPMENT ALTERNATIVES FOR THE MISSISSIPPI ALLUVIAL PLAIN IN EASTERN ARKANSAS.
Geological Survey, Little Rock, AR. Water Resources Div.

For primary bibliographic entry see Field 6A.
W91-03087

REASSESSING ESTIMATES OF GREAT LAKES CONSUMPTIVE USES AND IMPACTS.
Corps of Engineers, Chicago, IL. North Central Div.
D. J. Leonard, and R. Manam.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 33-44, 10 fig, 2 tab, 11 ref.

Descriptors: *Consumptive use, *Environmental impact, *Great Lakes, *Lake management, *Water policy, *Water resources management, Canada, Estimating, Interagency cooperation, Projections, Water use.

Several studies in the last decade have produced varying estimates of consumptive uses of Great Lakes waters. There are significant differences between the 1975 base year data developed by the U.S. Geological Survey (USGS) and the data used by the International Joint Commission's (IJC's) International Great Lakes Diversions and Consumptive Uses Study Board. The projected estimates of the Study Board were compared with the revised estimates generated by the IJC and the USGS as part of IJC's Reference Study of 1981, and new water-use data were compiled by the USGS for the years 1980 and 1985. Consumptive water use, the portion of water withdrawal that is not returned to the Great Lakes system, is expected to be five times greater in 2035 than it was in 1975. Consumptive use is estimated to increase from 7% of total withdrawals in 1975 to 15% in 2035. Manufacturing consumed 53% of the total consumptive use in 1975, with municipal consumption at 16%, and the power industry at 10%. These three sectors accounted for 80% of the water consumed in 1975 and may increase to 92% in 2035. Based on the 1980 and 1985 consumptive use data developed by the USGS the rate of consumptive use increase is estimated to be 218.4 cfs/year, which is higher than the IJC (1985) value of 115.6 cfs/year. A possible range of projected values for consumptive use for the year 2000 is between 4500 and 6500 cfs. Current plans are to undertake a detailed study to reevaluate the projection methods and the significance of consumptive use impacts during drought situations. (See also W91-03672) (Fish-PTT)
W91-03676

RECREATIONAL BEACH ENVIRONMENT: PERCEPTIONAL DIFFERENCE OF USERS, EMPLOYEES, AND THE PUBLIC.
State Univ. of New York Coll. at Cortland. Dept. of Recreation and Leisure Studies.
R. B. Buerger, J. F. Palmer, and T. A. More.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 269-278, 3 tab, 16 ref. NOAA U.S. Department of Commerce, Sea Grant College, New York Sea Grant Institute Grant No. NA81AAD00027.

Descriptors: *Beaches, *Great Lakes, *Lake Ontario, *Lake management, *Public opinion, *Recreation, *Surveys, *Water resources management, Economic aspects, Lake shores, New York, Public participation, Social aspects.

A study was performed to investigate what attributes beach users, those employed at the beach and the general public, perceive as important in the coastal recreation environment. During the summer of 1982, 300 beach users and 99 beach employees at three New York State park beaches along the southeast shore of Lake Ontario were personally interviewed. Beach users and beach employees were asked to evaluate 20 beach attributes based on their own personal perception. In 1984, 52 randomly selected City of Oswego (lake shore community near test beaches) residents (public) evaluated the same 20 beach attributes using a mail questionnaire. A comparison of the beach user and public responses showed a significant difference in perception of the beach attributes 'low cost of entrance' (important for public), 'opportunity to see wildlife' (public), and 'rules and regulations' (public). Moderately significant differences were indicated for the attributes 'socializing at the beach' (public), 'weather' (user), and 'people who work at the beach' (public). All demographic variables were significantly different between beach users and the public except for the variable 'income.' The results of this study indicate that beach users are not a cross-section of the public social strata but do have similar economic resources at their disposal. Also, the two groups perceive the beach environment differently specifically in terms of how people at the beach should be managed. Beach employees' own perceptions of the beach were not similar to either group and should not be used alone to make decisions about how to manage recreational use at the beach. (See also W91-03672) (Author's abstract)
W91-03701

EXCURSION, CRUISE AND PASSENGER FERRY SERVICES ON THE GREAT LAKES AND ST. LAWRENCE RIVER.
Great Lakes Commission, Ann Arbor, MI.
S. J. Thorp.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 285-294, 7 ref.

Descriptors: *Great Lakes, *Lake management, *Recreation, *Tourism, *Water resources management, Boating, Economic aspects, Navigable waters, Ships, Travel.

Passenger vessel activity on the Great Lakes and St. Lawrence River is undergoing a renaissance. At present, several million people take these excursions and ferry trips during the navigation season. In addition, several hundred thousand passengers, with their vehicles, board ferries each year. In 1987, large liner cruises on the lower St. Lawrence River set a modern-day passenger record. However, passenger movement by vessel mode is substantially less than what it was when immigrants boarded boats for westward destinations and millions of travelers embarked on trips during the famed 'Resort Era' in the early twentieth century. The upswing in patronage reflects the general increase in tourism and outdoor recreation activity in North America and the Great Lakes Region. An increasing number of excursion firms own or manage other complementary businesses and several are subsidiaries themselves. Another trend is broader geographic dispersion by independent firms and multiple service locations for individual companies. In the wake of this current interest, feasibility studies and marketing surveys have been completed indicating substantial demand for multi-day cruise service for the Great Lakes and St. Lawrence System. New opportunities for market growth and attention to efficient operations will guide future profitability. The overnight cruise sector has rediscovered the St. Lawrence River and may be on the verge of coming back to the Great Lakes. (See also W91-03672) (Author's abstract)
W91-03703

6E. Water Law and Institutions

WATER QUALITY INITIATIVE OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.
For primary bibliographic entry see Field 5G.
W91-02986

WATER: LAWS AND MANAGEMENT.
Contributed Papers and Abstracts for the Conference held September 17-22, 1989, Tampa, Florida. American Water Resources Association, Bethesda, Maryland, 1989. 820p.

Descriptors: *Conferences, *Groundwater management, *Legal aspects, *Legislation, *Water law, *Water management, *Water resources development, *Water resources management, Databases, Environmental protection, Regulations, Water supply development, Wetlands.

These proceedings present papers from the conference which have been divided into 28 sections: (1) National water policy; (2) Regional water resources management; (3) Comprehensive water resource planning; (4) Water resources policies studies; (5) Water resources information management and data sharing; (6) Water resources database design and utilization; (7) National water quality assessment programs; (8) Wetland management techniques; (9) Water regulations in Florida; (10) State's water rights; (11) Water use regulations and allocations; (12) Reclaimed water panel discussion; (13) Water quality treatment studies; (14) Water quality treatment criteria; (15) Hydrologic data measurements and models; (16) GIS as a tool for water resources management; (17) Groundwater management issues; (18) Groundwater management protection; (19) Water resources education; (20) Management tools for water resources management programs; (21) Flood water management; (22) Project management; (23) Hydrologic modeling of water quality impacts; (24) Environmental management; (25) Water supply management-I; (26) Water supply management-II; (27) Water use management; and (28) Basin planning and watershed management. (See W91-03033 thru W91-03096) (Lantz-PTT)
W91-03032

TWO STATES, TWO POLICIES: WETLANDS AND MINING IN ALASKA AND PENNSYLVANIA.
Pennsylvania State Univ., University Park. Graduate School.
E. G. M. Meij, L. K. Davis, and R. P. Brooks.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 1A-5--1A-13, 1 tab, 20 ref.

Descriptors: *Alaska, *Clean Water Act, *Legal aspects, *Mining, *Pennsylvania, *Water law, *Water management, *Water pollution control, *Wetlands, Economic aspects, Environmental protection, Federal jurisdiction, Public policy, State jurisdiction.

The Clean Water Act provides guidelines for wetland protection on a national basis in the absence of a comprehensive national policy for wetlands protection. Implementation of the Clean Water Act by the Corp of Engineers, the EPA, and state environmental agencies has resulted in regional variations in wetland management and protection. Without clear national standards for wetlands protection, these agencies determine regional wetlands policies during the permitting process. Industry-specific permit decisions further fragment the wetland protection inherent in the Clean Water Act. The emergence of regional policies is demonstrated with examples of coal mining in Pennsylvania and gold mining in Alaska. The organizational structure of the state and federal agencies which administer mining permits in these two states contribute to regional variation in wetlands protection. Regional variations also arise from differences in economic base, degree of development, percentage of wetlands in private versus public ownership, availability of a wetland inventory, and physiography. In Pennsylvania where wetlands are scarce, the population density is high, the economy is diversified, and most mining takes place on private lands, the state has developed strict regulations to protect wetlands. In Alaska where wetlands are abundant, the population density is very low, the economy depends heavily on the natural resource base, and mining takes place predominantly on public lands, national regulations such as the Clean Water Act are relied upon for wetland protection. (See also W91-03032) (Author's abstract)
W91-03033

WATER MANAGEMENT PLANNING: A PERSPECTIVE FROM THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT.
Southwest Florida Water Management District, Brooksville.
For primary bibliographic entry see Field 6A.
W91-03037

RESPONSE TO THE ALABAMA ENVIRONMENTAL PROTECTION PLAN.
Water Cycle Concepts, Inc., Auburn, AL.
For primary bibliographic entry see Field 6A.
W91-03039

OVERCOMING INSTITUTIONAL BARRIERS AND CONSTRAINTS TO WATER QUALITY MANAGEMENT.
University of Tennessee, Planning Research Center, Knoxville, TN.
For primary bibliographic entry see Field 5G.
W91-03041

ROLE OF PLANNING IN RESOLVING WATER POLICY DISPUTES.
Montana Dept. of Natural Resources and Conservation, Helena. Water Resources Div.
For primary bibliographic entry see Field 6A.
W91-03042

MANAGING GROUNDWATER IN TEXAS: THE CHANGING PACE OF REGULATION.
Texas Tech Univ., Lubbock. Dept. of Geography.
For primary bibliographic entry see Field 4B.
W91-03053

STATE WATER ALLOCATION LAW: ITS TRADITIONAL AND EMERGING ROLES.
Virginia Polytechnic Inst., Blacksburg. Dept. of Civil Engineering.
W. E. Cox.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 5B-3--5B-9, 6 ref. USGS Grant No. 14-08-0001-G1481.

Descriptors: *Water allocation, *Water demand, *Water law, *Water management, Competing use, Legal aspects, Legislation, State jurisdiction, Water use.

Water allocation laws are a fundamental component of the institutional framework for state water resources management. The definition of property interests is essential to water use and development. The basic function of water law is to facilitate the application of water to those uses which best contribute to social welfare. Although this function remains the same, the types of conflicts that must be resolved vary over time in response to changing views of the public interest. A traditional role of water law has been the resolution of conflict among competing offstream water uses. This function continues to be important, but increasing offstream use has required the recognition of a second function of water law: the protection of environmental conditions dependent on instream flow. Another increasingly important role is the resolution of interjurisdictional political conflicts arising over water transfer. Water law has not functioned well in this area. Weaknesses in resolving interjurisdictional conflict indicate the need for further evolution, if water law is to continue to serve its intended function effectively. (See also W91-03032) (Author's abstract)
W91-03055

ECONOMIC EFFICIENCY AND INSTITUTIONAL CHANGE IN WATER ALLOCATION: THE 1987 HAWAII WATER CODE.
Hawaii Univ., Honolulu. Water Resources Research Center.
J. E. T. Moncur.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 5B-23--5B-30, 19 ref.

Descriptors: *Economic aspects, *Hawaii, *Institutional constraints, *Legislation, *Water allocation, *Water management, *Water resources management, Legal aspects, Regulations, State jurisdiction, Water resources development, Water transfer.

In response to a 1978 constitutional amendment, Hawaii's 1987 legislature enacted a State Water Code. The code establishes a regulatory and administrative mechanism, but leaves almost completely up to its new Commission on Water Resources Management the crucial matter of criteria and institutional framework for assignment, and especially transfer, of water rights. The emergent institutional framework will largely determine the economic efficiency of water use in Hawaii, in conventional uses as well as in maintaining water quality and aesthetic values. With potable ground and surface water sources all but exhausted in some parts of the state, the conventional supply augmentation approach to satisfying water demand means developing expensive desalination. The alternative, demand management, requires attention to the means of obtaining and transferring the right to use water. An examination of the economic efficiency of the institutions emerging from implementation of the code is presented, including the possibilities for water marketing. (See also W91-03032) (Author's abstract)
W91-03057

ANTIDEGRADATION: A NEW LEVEL OF WATER QUALITY CONTROL. THE COLORADO EXPERIENCE.
Vranesh and Raisch, Boulder, CO.
For primary bibliographic entry see Field 5G.
W91-03062

DESIGN AND LEGALITY OF AN INNOVATIVE APPROACH TO NONPOINT SOURCE CONTROL.
Environmental Defense Fund, New York.
For primary bibliographic entry see Field 5G.
W91-03063

STATE WATER QUALITY LAWS AND PROGRAMS TO CONTROL NONPOINT SOURCE POLLUTION FROM FOREST LANDS IN THE SOUTH.
Georgia Univ., Athens. School of Forest Resources.
For primary bibliographic entry see Field 5G.
W91-03064

LEGAL ISSUES IN SURFACE WATER AND GROUNDWATER HAZARDOUS SUBSTANCES CONTAMINATION CASES.
Huey, Guilday, Kuersteiner and Tucker, Tallahassee, FL.
For primary bibliographic entry see Field 5G.
W91-03069

STATE AND LOCAL GROUND-WATER PROGRAMS RELATED TO WELLHEAD PROTECTION.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
For primary bibliographic entry see Field 4B.
W91-03070

EFFECTIVE ENVIRONMENTAL ACTION: THE CASE OF THE WEKIVA RIVER.
Saint Johns River Water Management District, Palatka, FL. Dept. of Water Resources.
N. S. Whitney, and J. C. Elledge.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 9B-13--9B-22, 1 fig, 7 ref.

Descriptors: *Environmental protection, *Florida, *Public participation, *Regulations, *Wekiva River, Case studies, Environmental policy, Legislation.

Tools that are needed to accomplish legislative acts in favor of conservation of natural resources include technical support, organization, persistence and an effective spokesperson. The citizen or group endeavoring to change the system in favor of environmental legislation must establish credibility and build support for the desired changes. In the recent case of the Wekiva River Protection Act, the Friends of the Wekiva River (FOWR), a central Florida environmental group, demonstrated that well organized and persistent groups can accomplish meaningful improvements to resource protection regulations. FOWR accomplished this by building support in the press and the affected agencies. This case may provide a model for further environmental action initiatives. (See also W91-03032) (Lantz-PTT)
W91-03073

INFORMATION: THE MOST UN-MANAGED RESOURCE IN WATER MANAGEMENT.
QUAD Data Corp., Tallahassee, FL.
For primary bibliographic entry see Field 7C.
W91-03074

NONTRIBUTARY GROUND WATER AS A MUNICIPAL SUPPLY IN THE DENVER METROPOLITAN AREA.
Denver Water Dept., CO.
For primary bibliographic entry see Field 4B.
W91-03086

PROMOTING REGIONAL WATER SUPPLY DEVELOPMENT: A CASE STUDY FROM SOUTHWEST FLORIDA.
Southwest Florida Water Management District, Brooksville.
D. W. Meinhart.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 12B-1--12B-10, 2 fig, 1 tab, 4 ref.

Descriptors: *Florida, *Public relations, *Water resources development, *Water resources management, *Water supply development, Case studies, Legislation, Public policy, Southwest Florida Water Management Distr, Water management.

The regional water supply development concept in southwest Florida was born out of the Tampa Bay-area water supply problems of the 1960's and 1970's. During this period, competition for a finite resource was heightened by rapid population growth. Accordingly, legislation was enacted which allowed regional water supply authorities to be created for the purpose of developing, storing, and supplying water across governmental boundaries. This legislation also directed Florida's five water management districts to assist water supply authorities meet demands in a manner giving priority to conservation and the reduction of environmental impacts associated with excessive or improper withdrawals of water from concentrated areas. In the Southwest Florida Water Management District (SWFWMD), three multi-jurisdictional water supply authorities are in varying stages of operation and fiscal maturity. The SWFWMD has been actively involved in promoting the development of each authority. At the staff level, assistance has been provided primarily through the planning process. At the policy level, assistance has been provided through the utilization of ad valorem tax revenues and land acquisition programs. Future promotion of the regional concept by the SWFWMD is expected to be directed toward supply development and dependability, reuse, and conservation. (See also W91-03032) (Author's abstract)
W91-03088

MANAGING GOVERNMENT REGULATION AND PUBLIC PERCEPTION OF BIOTECHNOLOGY FIELD TESTS: A CASE STUDY.
BioTechnica Agriculture, Inc., Cambridge, MA.
For primary bibliographic entry see Field 5G.
W91-03111

GROUNDWATER POLLUTION PROTECTION: A MULTIDISCIPLINARY ACTION TO BE LED BY A PRACTISING HYDROGEOLOGIST AND BACKED UP BY AN ENFORCEMENT OF LAW.
Lille-1 Univ., Villeneuve d'Ascq (France). Lab. d'Hydrogeologie.
For primary bibliographic entry see Field 5G.
W91-03193

DEVELOPING A STATE WELLHEAD PROTECTION PROGRAM: A USER'S GUIDE TO

ASSIST STATE AGENCIES UNDER THE SAFE DRINKING WATER ACT.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
For primary bibliographic entry see Field 5F.
W91-03222

ECONOMIC IMPACT STUDY OF PROPOSED AMENDMENTS TO ILLINOIS ADMINISTRATIVE CODE 604.203 AND 605.104 OF SUBTITLE F PUBLIC WATER SUPPLIES (TRIHALOMETHANES) R84-12.
Blaser, Zeni and Co., Springfield, IL.
W. L. Blaser, J. R. McQuown, W. H. Hallenbeck, D. J. Goodwin, and W. R. Rickert.
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-152706. Price codes: A09 in paper copy, A01 in microfiche. Report no. ILENR/RE-EA-89/02, January 1989. 187 p, 36 tab, 33 ref, 7 append. Contract no. EA 49.

Descriptors: *Administrative regulations, *Drinking water, *Economic impact, *Illinois, *Trihalomethanes, *Water quality standards, *Water treatment, Chlorination, Cost-benefit analysis, Monitoring, Public health, Surface water, Water pollution control, Water quality control, Water supply.

In October of 1982, the Illinois Pollution Control Board (IPCB), conforming to federal regulations, adopted a regulatory program to protect individuals from trihalomethanes (THMs) in drinking water. The program included establishing a maximum allowable concentration of 0.10 mg/L, and further provided for a systematic monitoring program. A study was performed to provide the IPCB with economic, public health and ancillary information to assist its members in deciding whether to adopt a rule which would apply current Maximum Contaminant Level (MCL) standards for total THM to surface-connected water supplies with populations of fewer than 10,000 individuals. The public water supplies which would be affected by the proposed regulation were identified, classified, and described. The IPCB proposal provided for the use of a one-sample maximum trihalomethane potential test annually to determine which supplies should follow a monitoring program to test four samples for each quarter. The IEPA proposal suggests a single-sample total THM test instead, and would cost $18,050 less than the IPCB proposal. Strategies for controlling THMs to comply with the MCL of 0.10 mg/L fall into three categories: (1) reducing precursors before chlorination, (2) use of disinfectants that generate fewer THMs, and (3) reducing THMs after they are formed. The principal costs of health effects (based on ingestion of drinking water) of the proposed THM rule are health care costs and loss of income from early death. Dollar-denominated costs of the proposed THM program exceed the dollar-denominated benefits. (Fish-PTT)
W91-03231

SUSQUEHANNA RIVER BASIN COMMISSION 1989 ANNUAL REPORT.
Susquehanna River Basin Commission, Harrisburg, PA.
Susquehanna River Basin Commission, Harrisburg, PA. 1990. 0 p. 17 fig, 3 tab.

Descriptors: *Interstate commissions, *River basins, *Susquehanna River, *Water resources management, *Watershed management, Administrative regulations, Fish management, Flood plain management, Gages, Groundwater management, Hydroelectric power, Maryland, New York, Pennsylvania, Selective withdrawal, Water use.

The Susquehanna River Basin Commission was created by the states of New York and Maryland, the Commonwealth of Pennsylvania, and the United States to manage the water resources of the Susquehanna River Basin. During 1989, a total of 96 projects were reviewed by the Commission. Several project review items that deserve special mention are: Groundwater Withdrawal Regulation Enforcement; Consumptive Water Use Survey; Debris Management; Amended Regulations; Water Allocations--Yellow Breeches and Conodoguinet Watersheds; Dock Street Dam Hydroelectric Project; and Migratory Fish Restoration. In 1984-85, the Commission proposed upgrading the flood forecast and warning system in the Susquehanna River Basin, to improve flood forecasts within the Susquehanna River Basin. The work accomplished to date includes: installation or upgrading raingages and streamgages, installation of a new computer, additional staff, construction of two radio transmission towers, and improvements to weather radar display and staff capabilities. During 1989, a significant amount of construction work was completed on the Cowanesque Water Storage Project in Tioga County, Pennsylvania: intake tower modifications and access road relocation, slope modification, fish and wildlife mitigation, recreation modifications, and reservoir cleaning. The Commission continues to implement the plan developed in 1985 to monitor suspended sediment and nutrient loadings in the Susquehanna River. Other noteworthy projects are: Information Requests, and SRBC In-House Computer System. (Fish-PTT)
W91-03243

MITIGATION AND THE SECTION 404 PROGRAM: A PERSPECTIVE.
Environmental Protection Agency, Atlanta, GA. Region IV.
W. L. Kruczynski.
IN: Wetland Creation and Restoration: The Status of the Science. Island Press, Covelo, California. 1990. p 549-554, 10 ref.

Descriptors: *Alternative planning, *Water law, *Water resources management, *Wetland restoration, *Wetlands, Compensation, Environmental engineering, Environmental impact, Governmental interrelations, Interagency cooperation, Project planning, Water resources development.

Although the basic language of Section 404 of the Federal Water Pollution Control Act Amendments of 1972 has not changed substantially since the program's inception, the program has evolved through revisions in U.S. Army Corps of Engineers (Corps) Regulations and Environmental Protection Agency (EPA) Guidelines, and the judicial history of wetland case law. Compensatory replacement mitigation appeared early in the program as an attempt to replace loss of wetlands, at least on paper. It appeared in projects for which federal commenting agencies chose not to dispute issuance of a Corps permit. The EPA and the Corps are currently negotiating a joint mitigation policy, but there remains a difference of opinion between the agencies concerning how mitigation should be considered in the permitting process. It is the EPA's position that the presumption that there are alternatives to the destruction of wetlands cannot be overcome by the applicant's promise to create new wetlands. However, compensatory replacement mitigation may be appropriate for projects for which there are no practicable alternatives and all appropriate and practicable minimization has been required. There are three categories of proposed projects, those for which impacts are: (1) significant regardless of proposed mitigation, (2) significant unless sufficiently offset by mitigation, and (3) not significant. Consideration of the role of compensatory mitigation for projects which are not immediately rejected from further consideration because of the magnitude of the environmental losses must be made on a case-by-case basis. (See also W91-03244) (Author's abstract)
W91-03271

WHAT COMMUNITY LEADERS HAVE TO DO TO MAKE RECLAMATION HAPPEN.
San Diego County Water Authority, CA.
D. Mason.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 19-23.

Descriptors: *Legal aspects, *Policy making, *Public participation, *Reclaimed water, *Water reuse, Economic aspects, Marketing, Public policy, Water policy.

The private citizen committee member and board member can play a role in water reclamation. The water districts must talk to their customers and become marketing people. To make reclamation work it is necessary to find out what the customers' needs are and to take the time to understand the market. It will be necessary to invest time and money into the program. Traditionally the water business solved problems through regulation. With water reclamation, it is suggested that along with the 'stick' the customers must be offered the 'carrot'. When rules and regulations become an obstacle, it is necessary to look beyond them to challenge the criteria and the decision makers. Challenge is the basis on which rule and regulation is built. If the challenge is proper accept it; if not change it. People can change it and that is an elected official's role. People can go before their political leaders, whether they represent a Regional Water Quality Control Board or the state board. Everyone can become involved in water reclamation. People must change from being involved to being committed. (See also W91-03273) (Agostine-PTT)
W91-03276

REGULATIONS THAT ENCOURAGE RECLAMATION.
G. Arant.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p 25-31.

Descriptors: *California, *Legal aspects, *Reclaimed water, *Regulations, *Wastewater management, *Water reuse, Economic aspects, Public policy, Water policy, Water resources management.

The regulations affecting reclamation are there to fill a primary function: protection of water quality and public health and safety. Region IX's comprehensive water quality control plan report which established the water quality standards and objectives for the region's eleven hydrologic basins and fifty-four subunits was adopted in 1975. Three years later in 1978, the regional board amended basin plans for nineteen coastal subunits, removing all water quality objectives and clearing the way for reclamation projects in those areas. Recently the regional board adopted revised basin objectives for the Salt Creek basin which will allow the use of reclaimed water on developments within the service area of the Otay Municipal Water District. Each new basin plan study and application for amendments will be evaluated on its own merits by the regional board. The regulations have not really changed to encourage reclamation. Economic, political, and sociological factors have converged to bring water reclamation to the forefront in water resource planning. These factors have added new interests and momentum to making reclamation happen here and now. This momentum will drive through the regulatory road blocks, constraints, or hurdles which have continually, and most times unfairly, been cited as the reason why San Diego region and many others have not yet met the full reclamation potential. Another sociopolitical event which has significantly pushed the scale in favor of reclamation has been the virtual demise of the U.S. EPA 301(h) waiver process, which allowed for reducing treatment levels for ocean discharge. Finding beneficial uses for reclaimed water will ease the pressure to expand coastal treatment facilities, lessen land and ocean outfalls, encourage the development of more cost effective inland treatment facilities, as well as provide a new source of revenue for the sewering agency. (See also W91-03273) (Agostine-PTT)
W91-03277

STATE LEGISLATURE'S VIEW OF RECLAMATION.
M. Dillon.
IN: Symposium III, Association of Water Reclamation Agencies, October 13-14, 1988. Water Reclamation: Here, Now...and How. Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1990. p

33-40.

Descriptors: *California, *Legislation, *Political constraints, *Reclaimed water, *State jurisdiction, *Water reuse, Legal aspects, Political aspects, Water shortage.

Water reclamation is only one of hundreds of issues before the state legislature. Issues generally surface in one of several ways. They may surface because of a crisis. An issue may surface from people with special interests. A third way is from legislators who may take a keen interest in an issue. A fourth way is from state departments themselves, like the State Water Resources Control Board (SWRCB) or the Department of Water Resources. The staff to one of the key senate committees of the state legislature feels that water reclamation is not the solution to the water problems. On the assembly side there is a stronger interest. Legislators from areas where there is not a water shortage such as northern California show less interest than those from areas such as southern California which is experiencing water shortages. State agencies have generally tried to convince the legislature and the governor that water reclamation will go a long way toward solving some of the water problems. The most consistent champion of water reclamation in Sacramento has been the State Water Resources Control Board. The board has been the sponsor of the Clean Water Bond Act since 1970. For the future it is anticipated that most legislators will have little interest in water reclamation, and without a crisis it will probably continue to be a nonissue before the legislature. It is incumbent upon everyone in water reclamation to educate every senator and assemblyman as to the need for water reclamation, what is currently being done and why their help is needed. It is important to get the legislators out to see water reclamation projects. (See also W91-03273) (Agostine-PTT)
W91-03278

ILLINOIS DEPARTMENT OF CONSERVATION'S CHANGING ROLE IN THE ILLINOIS RIVER BASIN.
Illinois Dept. of Conservation, Springfield.
J. W. Comerio.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 15-18.

Descriptors: *Illinois, *Illinois River Basin, *State jurisdiction, *Water resources management, *Watershed management, Conservation, Environmental protection, Institutions, Public policy, Recreation, Resources management, Water resources institutes.

The Illinois Water Department (IWD) traditionally has been viewed as a natural resource conservation and recreation provision agency, with little impact on the state's economy. However, the relationship between the Illinois tourism industry and the state's quality of life is becoming more obvious. A $120 million park and conservation program, known as PCII, was appropriated to improve tourism. PCII includes expansion of overnight accommodations at department sites with several possible new public-private joint ventures if economically warranted; development of visitor centers and visitor information facilities; development of swimming pools and beaches; campground expansion and the addition of shower buildings; development of day use facilities and trails; and basic infrastructure improvements. The IWD has also made some internal changes to strengthen its economic development role. The Office of Resource Marketing and Education has been formed to better promote conservation sites, facilities, and programs. Tourism is one of the state's fastest growing industries and a vital part of Illinois' economic development. (See also W91-03608) (Lantz-PTT)
W91-03609

ILLINOIS RIVER SOIL CONSERVATION TASK FORCE.
For primary bibliographic entry see Field 4D.
W91-03622

STREAM BANK STABILIZATION AND THE ILLINOIS RIVER SOIL CONSERVATION TASK FORCE.
Illinois River Soil Conservation Task Force, Eureka, IL.
For primary bibliographic entry see Field 4D.
W91-03623

ILLINOIS RIVER COALITION/FATHER MARQUETTE COMPACT.
Caterpillar Tractor Co., Peoria, IL.
H. Holling.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 145-146.

Descriptors: *Illinois, *Illinois River, *Public participation, *Water resources institutes, *Water resources management, Economical aspects, Local governments, Public policy.

The Illinois River Coalition/Father Marquette Compact (IRC/FMC) was formed in February 1988 to serve the advocacy objective on a regional basis. The coalition was incorporated by interested citizens from Jersey, Peoria, Tazewell, Marshall, and LaSalle counties. Meetings were established to begin a dialogue among those who want to save the water resource. The meeting format consists of status reports on significant river related matters and a discussion of strategies for gathering maximum support from governmental authorities. There is no budget and the IRC/FMC functions with a volunteer staff. Progress in generating ongoing regional discussions and consensus building has been slow. However, experience to date indicates that the concept of a system wide advocacy committee is valid and can work. The work program for the next three months calls for three to four regional meetings, publication of a newsletter, and heightened acceptance of cooperation and communication aimed at saving the Illinois River. (See also W91-03608) (Lantz-PTT)
W91-03626

COMPARISON OF COMMERCIAL-COMMODITY AND RECREATIONAL USE OF THE ILLINOIS RIVER SYSTEM: THE CASE OF THE ILLINOIS AND MICHIGAN NATIONAL HERITAGE CANAL CORRIDOR.
Illinois Univ. at Urbana-Champaign. Inst. for Environmental Studies.
R. J. Burdge, and R. A. Robertson.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 150-155, 2 tab.

Descriptors: *Case studies, *Illinois, *Illinois River, *Recreation, *Water use, Canals, Competing use, Federal jurisdiction, Legislation, River systems, Surveys, Water resources development.

A substantial portion of the US population lives within a short drive of one of 18 major river corridors. These corridors represent the closest opportunity for the 'wilderness' recreation experience that millions of urban residents ever have. With the support of the Illinois congressional delegation, community and environmental groups convinced Congress to designate the Illinois River Corridor as a National Heritage Corridor. The stated purpose of the Illinois and Michigan National Corridor is to 'retain, enhance and interpret, for the benefit and inspiration of present and future generations, the cultural, historical, natural, recreational and economic resources of the corridor, where feasible, consistent with economic growth'. Besides inventorying the historical, archaeological, biological, geological and recreational resources of the corridor, the impacts of commercial and industrial activity on recreation use in the Upper Illinois Waterway are studied. This study includes the relationships among the many diverse and competing uses of the Upper Illinois Waterway and provides information that can be used by planners, managers and politicians interested in developing commercial/industrial developments near existing recreation areas. Interviews with recreation site visitors and managers as well as state and federal planners were conducted to identify the kinds of problems that corridor visitors encounter when using this industrial/commercial area for recreation. (See also W91-03608) (Lantz-PTT)
W91-03628

USEPA PERSPECTIVE ON NONPOINT POLLUTION CONTROL AND WETLANDS FUNCTION.
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 5G.
W91-03631

STATE GROUNDWATER PROTECTION POLICIES: A LEGISLATOR'S GUIDE.
National Conference of State Legislatures, Denver, CO.
For primary bibliographic entry see Field 5G.
W91-03657

WATER AND THE ENVIRONMENT: THE IMPLEMENTATION OF EUROPEAN COMMUNITY DIRECTIVES ON POLLUTION CAUSED BY CERTAIN DANGEROUS SUBSTANCES DISCHARGED INTO THE AQUATIC ENVIRONMENT.
Department of the Environment, Cardiff (Wales). Welsh Office.
For primary bibliographic entry see Field 5G.
W91-03661

AGENDA FOR THE MANAGEMENT OF THE GREAT LAKES ON A LONG TERM ECOSYSTEM BASIS.
Cornell Univ., Ithaca, NY.
L. B. Dworsky, and D. J. Allee.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 21-32, 3 fig, 1 tab, 9 ref.

Descriptors: *Environmental protection, *Governmental interrelations, *Great Lakes, *Lake management, *Water policy, *Water resources management, Canada, Ecosystems, Education, Environmental policy, Institutions, Management planning, Regulations.

The 1909 Boundary Water Treaty between the United States and Great Britain has been acknowledged as a most successful binational agreement. The International Joint Commission (IJC) has dealt with 130 conflicts. Usually only responding to references from the two governments, in January 1985 the IJC issued a unique unrequested Advisory. The Advisory urged that the Great Lakes be managed on ecosystem basis, including values beyond water quality. Three seminar reports at Cornell University tested the feasibility of such an approach. The first report refers to citations and identifies and discusses the principal issues that would confront the two governments (The United States and Canada) in considering longer-term action for management of the Great Lakes Ecosystem. The second report aims to provide further aid and stimulus to the governments to initiate in-depth discussions. The third report suggests feasible tasks involving the implementation of ecosystem-derived plans and programs. Clearly the knowledge resources are available for a meaningful start to an ecosystem-based management process. But implementation requires greatly expanded understanding by those involved in each issue. An expanded role for the IJC could be a key in facilitating this step to institutional capacity building. (See also W91-03672) (Author's abstract)
W91-03675

FLUCTUATING GREAT LAKES WATER LEVELS: EXPECTATIONS AND THE IJC.
International Joint Commission-United States and Canada, Ottawa (Ontario).
M. Clamen.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 75-81, 11 ref.

Descriptors: *Governmental interrelations, *Great Lakes, *International commissions, *Lake management, *Water level fluctuations, *Water resources management, Canada, Coastal zone management, Interagency cooperation, Lake shores, Regulations, Shore protection.

The shared history of the Great Lakes is at an important juncture. Although water levels have fluctuated widely in the last several decades, in 1986 all lakes, except Lake Ontario, established new 20th century record highs. Considerable shoreline flooding, erosion, and associated coastal zone problems resulted as well as public demands for action. Solutions that have been considered previously include: further lake level regulation, interbasin diversion modification, shoreline protection works, and modifications of shoreline practices. This issue is of central concern to the International Joint Commission (IJC) because of its responsibility in regulating the outflow from Lakes Superior and Ontario, and because of previous IJC studies on this subject over the past twenty years. In August 1986 the Governments of the United States and Canada agreed to request the Commission to examine and report upon methods of alleviating the adverse consequences of water level fluctuations, including the high water level crisis of 1986. The IJC believes the current study calls for a more comprehensive and far-reaching investigation than has been accomplished in response to any of the previous requests by Governments. (See also W91-03672) (Author's abstract)
W91-03680

GREAT LAKES WATER RESOURCES MANAGEMENT.
Corps of Engineers, Chicago, IL. North Central Div.
M. J. Todd, and J. W. Kangas.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 93-102, 3 tab, 14 ref.

Descriptors: *Governmental interrelations, *Great Lakes, *Lake management, *Water level fluctuations, *Water resources management, Channels, Computer models, Erosion, Flood damage, Flooding, Forecasting, Hydrologic budget, International commissions, Lake shores, Meteorological data collection, Precipitation, Regulations, Shore protection, Storms.

Excessive Great Lakes basin precipitation resulted in 1985-87 levels which broke all previous record high levels for all months and all lakes, except Lake Ontario. It caused considerable flooding and erosion damage along many reaches of the 5,000 miles of U.S. Great Lakes shoreline. Approximately 1,000 miles are subject to significant flooding and 500 miles are subject to severe erosion. Most of the damage occurs during periods of storm activity. The U.S. shoreland damages in 1972-76 were estimated to be about $200 million and the estimates for 1985-87, although not yet fully assessed, are expected to be somewhat higher, about $285 million. Limited outflow capacities of Great Lakes outlet channels cannot accommodate the high water supplies recently experienced. Complete regulation of the Great Lakes has been found in previous studies to be engineeringly feasible, but economically unjustified. Such measures are currently being reevaluated on a comprehensive basis by the International Joint Commission under a new Great Lakes Levels Reference Study. There are several innovative measures being investigated to partially alleviate current and future damages. Improvements of the U.S. Army Corps of Engineers' computer and mapping facilities, the real-time hydrometeorological data collection network system, and forecasting techniques are part of the measures being considered at this time. Many of these measures will use state-of-the-art models and data systems. Additionally, it is intended to explore and implement computer simulation models to better determine the hydrologic and hydrodynamic behavior of the lakes and the connecting channels and better manage this resource. (See also W91-03672) (Author's abstract)
W91-03682

UNITED STATES NONPOINT SOURCE PHOSPHORUS REDUCTION EFFORT.
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 5G.
W91-03691

NONPOINT POLLUTION: 1988-POLICY, ECONOMY, MANAGEMENT, AND APPROPRIATE TECHNOLOGY.
For primary bibliographic entry see Field 5G.
W91-03704

FEDERAL ENVIRONMENTAL LEGISLATIVE PROCESS.
Colorado State Univ., Fort Collins.
H. P. Caulfield.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 1-8, 10 ref.

Descriptors: *Environmental policy, *Federal jurisdiction, *Legislation, *Nonpoint pollution sources, *Political constraints, *Water pollution control, *Water pollution sources, *Water resources management, Agricultural chemicals, Decision making, Drinking water, Groundwater pollution, Public health, Water policy.

A conceptual framework of politics is often the result of many systems analyses prepared from the perspective of several scientific disciplines, presenting single or multiple conclusions or conclusions specifying possible political/environmental tradeoffs. The processes of legislative decision are identified as ideological adherence; bargaining, resulting in compromise; and vote trading. One particular concern of the Environmental Movement is the actual and potential degradation of groundwater from seepage of fertilizers and pesticides in rural areas affecting on-farm and rural community groundwater supplies utilized as drinking water. This public problem was considered hypothetically for possible solution by federal environmental legislation. The involvement of several forms of ideological adherence (maintenance of human health, economic well-being and progress, maintenance of the 'family farm,' and Creative or New Federalism) provide the basic standpoints from which bargaining among their adherents can occur. The main issue areas in which bargaining would appear to be needed include: health effects of agricultural chemicals in drinking water, groundwater pollution, federal taxes on agricultural chemicals, alternative drinking water sources, and distribution of federal tax revenues to provide needed subsidies. It was concluded that interest groups and legislators outside the agricultural community who identify ideologically with environmental health concerns generally could increase the likelihood of a major legislative breakthrough. The possible need for tradeoffs between decreased agricultural production and a decrease in groundwater pollution would appear to present a complex and far-reaching problem. (See also W91-03704) (Fish-PTT)
W91-03705

GROUNDWATER QUALITY: THE ROLE OF AGRICULTURAL POLITICS AND POLICY.
Iowa Univ., Iowa City. Dept. of Geography.
R. S. Roberts, and D. R. Lighthall.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 9-21, 2 fig, 1 tab, 26 ref.

Descriptors: *Agriculture, *Groundwater pollution, *Groundwater quality, *Iowa, *Nonpoint pollution sources, *Political aspects, *Water policy, *Water pollution sources, *Water resources management, Agricultural chemicals, Environmental policy, Farming, Government supports, Profit, Regulations, Water pollution control, Water quality control.

The growing problem of nonpoint-source groundwater contamination from agricultural chemicals has been conceptualized as a historical outcome of the production environment of capitalist agriculture in the Midwest. Alternative policy responses to contamination, such as the voluntary adoption of Best Management Practices, cross-compliance, site-specific regulation of chemical application, and taxation of synthetic chemicals were evaluated on the basis of their interrelationships with this institutional structure. Analysis of Iowa's policy response to contamination reveals a contradiction between intensified regulation of chemical use and the imperatives facing farmers seeking profits in competitive markets. As a result, a long-term solution of the problem will hinge on the development of profitable alternatives to current production technologies and a concomitant reorientation of the public sector research agenda. Considerable insight into possible avenues for groundwater quality protection policy can be gained by analyzing policy options for their political significance. The debate over particularities of governmental level or policy tools, however, risks masking a more fundamental point: any solution to nonpoint-source contamination of water supplies requires a comprehensive understanding of the source of contamination and the structural forces that determine its occurrence. (See also W91-03704) (Author's abstract)
W91-03706

GROUND WATER POLICY OF USDA.
Department of Agriculture, Washington, DC.
R. W. Long.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 23-27.

Descriptors: *Administrative agencies, *Agricultural chemicals, *Agriculture, *Groundwater, *Nonpoint pollution sources, *Water policy, *Water pollution control, *Water pollution sources, Conservation, Crop production, Drinking water, Environmental impact statement, Farming, Governmental interrelations, Public health, Research priorities, Water resources management.

The use of agricultural chemicals, especially pesticides and nutrients, has become widespread in the U.S. over the past three or four decades, causing increasing problems of nonpoint source contamination of drinking water supplies. While acknowledging the importance of environmental and health concerns, U.S. Department of Agriculture (USDA) policy continues to support the prudent use of agricultural chemicals in production agriculture. The USDA believes that voluntary solutions to natural resource problems is the best route to lasting progress. One of its greatest challenges is to improve coordination among its own programs and cooperation among its own agencies. Some of the actions that the USDA has undertaken recently include: placing additional emphasis on control of nonpoint source water pollution; coordinating an approach between the Soil Conservation Service and the Extension Service (two USDA agencies) for advising farmers and ranchers on practices that involve the use of agricultural chemicals; implementing the conservation provisions of the 1985 farm bill, which removes marginal land from production and promotes conservation on other farmland; extensive human health risk assessments in environmental impact statements where pesticide use is proposed; formation of a USDA Working Group on Agricultural Chemicals and the Environment; research priority on groundwater quality; and implementation of educational on-farm demonstrations designed to move new technology quickly to production agriculture. Over the next several years, the USDA will continue to strengthen the

policies recently set in place. (See also W91-03704) (Fish-PTT)
W91-03707

ECONOMIC IMPLICATIONS OF THE FOOD SECURITY ACT OF 1985'S DISCRETIONARY ENVIRONMENTAL PROVISIONS.
Economic Research Service, Washington, DC.
C. W. Ogg, and M. O. Ribaudo.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 49-56, 2 fig, 1 tab, 22 ref.

Descriptors: *Agriculture, *Conservation, *Economic aspects, *Environmental policy, *Legislation, *Nonpoint pollution sources, *Water policy, *Water pollution control, *Water resources management, Agricultural chemicals, Cost-benefit analysis, Cropland, Erosion, Erosion control, Groundwater mining, Irrigation, Riparian vegetation, Saline water, Surface-groundwater relations, Water quality management, Watershed management.

Erosion and crop surplus concerns in Congress led to inclusion of the Conservation Title in the Food Security Act of 1985, which established the Conservation Reserve Program (CRP). Although the CRP retired only highly erodible cropland in its first two years, other environmental problem cropland could gain CRP eligibility at the discretion of the Secretary of Agriculture. Stream buffers, which became eligible in 1988, are expected to provide much higher water quality benefits per acre than highly erodible acres. Enrolling saline, irrigated cropland would, however, produce higher off-site benefits only in certain river basins. Addressing groundwater mining through the CRP would result in much lower off-site benefits per acre than highly erodible acres currently enrolled. CRP rental payments for both surface and groundwater irrigated cropland would also be relatively high. The recent CRP changes and proposals being considered by Congress are increasingly focused on local water quality problems and can increase the overall environmental benefits from the program. Additional changes under consideration could in some instances also increase these benefits, but would affect other CRP program objectives, such as supply reductions and program costs. Only wet croplands appear to offer substantive potential for expanding the CRP unless program costs per acre enrolled are allowed to increase. (See also W91-03704) (Fish-PTT)
W91-03710

NONPOINT POLLUTION POLICIES AND POLITICS: THE ROLE OF ECONOMIC INCENTIVES.
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 5G.
W91-03711

INSTITUTION-SENSITIVE APPROACH TO THE USE OF ECONOMIC INSTRUMENTS FOR NONPOINT SOURCE WATER POLLUTION CONTROL.
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
For primary bibliographic entry see Field 5G.
W91-03712

ECONOMICS OF SILVICULTURAL BEST MANAGEMENT PRACTICES.
Forest Service, Atlanta, GA.
For primary bibliographic entry see Field 5G.
W91-03713

EQUITY AND EFFICIENCY ASPECTS OF ALTERNATE STORMWATER MANAGEMENT FINANCING SYSTEMS.
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
For primary bibliographic entry see Field 5G.
W91-03714

REVENUE SOURCES FOR NONPOINT SOURCE POLLUTION ABATEMENT: AN ECONOMIC ANALYSIS.
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 5G.
W91-03715

NONPOINT SOURCE REGULATION--A WATERSHED APPROACH.
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 4D.
W91-03717

IMPLEMENTATION OF THE NEBRASKA NITRATE CONTROL LEGISLATION.
Nebraska Natural Resources Commission, Lincoln.
D. Williamson.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 133-139, 8 ref.

Descriptors: *Environmental policy, *Groundwater management, *Legislation, *Nebraska, *Nitrates, *Nonpoint pollution sources, *Water pollution control, *Water pollution sources, *Water resources management, Agricultural chemicals, Farming, Fertilizers, Governmental interrelations, Irrigation wells, Soil analysis, Water analysis, Water policy, Water quality standards.

Nebraska is considered unique in the methods chosen to manage groundwater. Strong local groundwater quality management controls can be exercised by the 24 natural resources districts. These districts cover the entire state. The state provides oversight, and in event of lack of action on the part of a local district, the state can step in and require remedial and preventative action. The Central Platte Natural Resources District (CPNRD) is the first in the state to develop Special Protection Areas to control nonpoint source pollution of the aquifer. Nitrate concentrations in groundwater in many parts of the District now exceed the standard of 10 mg/L as nitrate-nitrogen. The District has applied phased protection areas: Phase I areas are those with the least pollution (0 to 12.5 mg/L nitrate) and the lowest level of control (producer inventories); Phase III areas have the highest rate of pollution (greater than or equal to 20.1 mg/L nitrate) and the most stringent controls (banning of fall and winter fertilizer application, groundwater supply management areas). The Phase II protection area now covers 440,000 acres and includes approximately 5,000 irrigation wells. Average nitrate concentrations in this area range from 12.6 to 20 mg/L. In addition to Phase I measures, Phase II farmers are required to attend irrigation and fertilizer management classes, and an annual water analysis is also required for each irrigation well as well as an annual deep soils analysis for each field, and farmers are required to submit annual reports. At this point, it appears that the NRDs and the Nebraska Department of Environmental Control are developing a good working relationship to help assure an effective water quality management program. (See also W91-03704) (Fish-PTT)
W91-03719

INTEGRATED RESOURCE MANAGEMENT: REGION V'S NONPOINT SOURCE CONTROL AND CLEAN LAKES PROGRAM.
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 5G.
W91-03721

SOUTHEASTERN MINNESOTA COOPERATES TO DEVELOP AN INNOVATIVE APPROACH TO NONPOINT POLLUTION.
Zumbro/Root River Water Quality Task Force, Minnesota.
P. K. B. Hunt, A. C. Persons, M. Lundberg, and G. Isberg.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 155-163, 1 fig, 8 ref.

Descriptors: *Governmental interrelations, *Management planning, *Minnesota, *Nonpoint pollution sources, *Water pollution control, *Water resources management, Comprehensive planning, Groundwater management, Interagency cooperation, Karst, Land resources, Political aspects, Water policy, Water quality management.

Southeastern Minnesota is very susceptible to erosion and has karst topography that is subject to groundwater contamination. The Minnesota Legislature recently enacted the Comprehensive Local Water Management Act. This legislation authorized the counties to address the issue of water and related land resources through local management. Nine counties in southeastern Minnesota in conjunction with state and federal agencies have joined together to address all water issues that transcend political boundaries. To date 80 percent of those issues are nonpoint in nature. This coalition of counties has recognized politics as an obstacle to the abatement of nonpoint pollution and have therefore developed strategies to address this vital issue. The nine counties have formed a regional task force as well as individual county committees to delineate and prioritize the issues, primarily involving water quality. Each county will have a comprehensive water management plan, but the plan will be coordinated with the contiguous counties. Case studies from two of the nine counties highlight the local organizational structure and water management planning efforts and issues. This water management planning program truly represents an intergovernmental approach to water resource planning and properly balances state and regional concerns with local issues. The water management plan will not be static and will be updated on a routine basis. (See also W91-03704) (Author's abstract)
W91-03722

INTEGRATED EXPERIENCE--THE MILWAUKEE RIVER EAST-WEST BRANCH WATERSHED RESOURCE MANAGEMENT PLAN.
Wisconsin Dept. of Natural Resources, Milwaukee.
For primary bibliographic entry see Field 4D.
W91-03723

STORMWATER PERMITS--A POINT SOURCE UMBRELLA FOR NONPOINT POLLUTION PROBLEMS.
Marquette Univ., Milwaukee, WI. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W91-03724

STORMWATER NONPOINT SOURCE POLLUTION CONTROL.
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 5G.
W91-03725

MARYLAND'S STORMWATER MANAGEMENT PROGRAM.
Maryland Dept. of the Environment, Annapolis. Sediment and Stormwater Div.
For primary bibliographic entry see Field 5G.
W91-03726

NEW STRATEGIES IN URBAN DRAINAGE AND STORMWATER POLLUTION CONTROL IN SWITZERLAND.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
V. Krejci.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p

203-211, 3 fig, 1 tab, 20 ref.

Descriptors: *Nonpoint pollution sources, *Storm water management, *Switzerland, *Urban drainage, *Water pollution control, Environmental impact, Management planning, Wastewater disposal, Wastewater treatment, Water policy, Water pollution sources, Water pollution treatment, Water resources management.

The new strategies in urban drainage and storm water pollution control are based on a better understanding of the entire system: the source of storm water and of the pollution-transport-transfer-treatment-manifestation and consequences in receiving waters and in groundwater. Similar to the existing water pollution control strategy for dry weather situations, it appears that in the future, urban drainage and storm water pollution control strategy will be more related to specifically-identified problems rather than giving general design recipes. This control strategy is supported by the new proposal of the Swiss Law for Water Pollution Control and especially by the revision of guidelines for the Master Plan of Urban Drainage. The most important change is the global consideration of quantity and quality aspects in planning, design, operation, and rehabilitation of urban drainage. Unfortunately, significant progress in the interpretation of observed pollution loads and their impact on the ecological state of receiving waters is not in sight. However, there are still possibilities for improving storm water pollution control without exact understanding of the ecological impact of urban runoff in general: (1) by changing from rapid and complete collection of wastewater from urban areas towards slow transport with a consistent separation of polluted and unpolluted wastewater and by infiltrating a high fraction of 'unpolluted' storm water runoff, there can be a significant reduction of discharged pollution; and (2) with the help of modern technical tools such as mathematical modeling, electronic and computer process control, planning, design, and operation of urban drainage can be significantly improved. (See also W91-03704) (Author's abstract)
W91-03727

IRRIGATION-INDUCED WATER QUALITY PROBLEMS: POLICY IMPLICATIONS OF DOI RECONNAISSANCE STUDY RESULTS.
National Irrigation Water Quality Program, Washington, DC.
For primary bibliographic entry see Field 5B.
W91-03735

IDENTIFYING AND MEASURING POTENTIAL CONFLICT IN WATER INSTITUTIONS.
Florida Univ., Gainesville. Dept. of Food and Resource Economics.
G. D. Lynne, J. W. Milon, and M. E. Wilson.
Water Resources Bulletin WARBAQ, Vol. 26, No. 4, p 669-676, August 1990. 1 tab, 18 ref.

Descriptors: *Administrative agencies, *Administrative regulations, *Institutional constraints, *Institutions, *Water allocation, Behavior, Case studies, Economic aspects, Florida, Social aspects, Water demand, Water supply.

Scarcity combined with differences in values, beliefs and attitudes can lead to behavior differences and conflicts over water. An index for measuring potential conflict using survey information about water attitudes and beliefs of individuals in three groups in a Florida case study (of the Southwest Florida Water Management District) was developed. The index was developed around the concepts of water scarcity, the role of water resources in producing end-state values such as economic growth and higher income, the equity of water distribution, and instrumental value dimensions such as responsibility, rationality and competency. This index suggests the extent to which individuals in different groups have diverging beliefs and attitudes. The index helps in assessing the current capability of the institution to reduce conflict. The results suggest that the current institution is effective, but changes may help to streamline the consumptive-use permitting process, to improve educational programs, and to seek improved institutional arrangements to reduce future conflict over economic uses of water. (Hoskin-PTT)
W91-03861

ENVIRONMENTAL IMPACT ASSESSMENT IN THE PEOPLE'S REPUBLIC OF CHINA.
Wisconsin Univ.-Green Bay. Coll. of Environmental Sciences.
R. B. Wenger, W. Huadong, and M. Xiaoying.
Environmental Management EMNGDC, Vol. 14, No. 4, p 429-439, 1990. 2 fig, 45 ref.

Descriptors: *China, *Environmental impact statement, *Environmental policy, *Environmental protection, *Resources management, Decision making, Management planning, Political aspects, Project planning, Social aspects.

Environmental impact assessment (EIA) procedures have been in existence in the People's Republic of China over the last decade. The impetus for China's introduction of EIA was provided by the Environmental Protection Law of the People's Republic of China, adopted by the Fifth National People's Congress in 1979. The EIA process, which is administrative and not statutorily mandated, has been applied primarily to construction projects. Four stages are typically involved in an EIA investigation: design of the investigation, evaluation of background environmental quality, prediction of environmental impacts, and an assessment and analysis of the environmental impacts. A variety of approaches are used for predicting and analyzing environmental impacts, ranging from ad hoc methods to fairly sophisticated mathematical models. The results of the EIA investigation are compiled in an environmental impact statement, which is used as the basis for decision making by personnel in environmental protection departments. The EIA process does not include provisions for citizen notification or involvement. Views differ concerning the effectiveness of the EIA program in protecting China's natural, social, and cultural environments. Some hold that the EIA program has brought about improvement in environmental protection, while critics contend that the program has had little effect in the prevention of pollution. Most observers seem to feel that the program should be continued and improved. A major avenue for improvement is to place the evaluation of a particular project in a regional context. (Author's abstract)
W91-03874

BINATIONAL MANAGEMENT OF HAZARDOUS WASTE: THE MAQUILADORA INDUSTRY AT THE US-MEXICO BORDER.
California Univ., Los Angeles. School of Public Health.
For primary bibliographic entry see Field 5G.
W91-03875

6F. Nonstructural Alternatives

SITE SELECTION MODEL FOR ACQUISITION OF WATER RESOURCE LANDS: A GIS APPLICATION.
Southwest Florida Water Management District, Brooksville.
For primary bibliographic entry see Field 7C.
W91-03067

MODEL FOR QUANTIFYING INCENTIVE PAYMENTS FOR SOIL CONSERVATION IN CROPPING REGIONS SUBJECT TO WATER EROSION.
La Trobe Univ., Bundoora (Australia). School of Agriculture.
For primary bibliographic entry see Field 4D.
W91-03140

SPECIAL FLOOD HAZARD EVALUATION REPORT: CANASERAGA CREEK, TOWN OF GROVE, ALLEGANY COUNTY, NEW YORK.
Army Engineer District, Buffalo, NY.
Available from the National Technical Information Service, Springfield, Virginia 22161, as AD-A210 303. Price codes: A03 in paper copy, A01 in microfiche. Final report, May 1989. 19 p, 1 fig, 3 tab, 7 ref, 4 plates.

Descriptors: *Flood forecasting, *Flood hazard, *Flood peak, *Flood plain management, *Land use, *New York, *Nonstructural alternatives, Computer programs, Hydrographs, Hydrologic data, Regression analysis.

Knowledge of potential floods and flood hazards is important in land use planning. An investigation was performed to determine the potential flood situation along a portion of Canaseraga Creek within the town of Grove, New York. No historical flood records exist and the stream is ungaged within the study area so flooding is not well documented. Hydrologic analyses were carried out to establish the 100-year peak discharges for Canaseraga Creek, using a regional regression equation and a computerized method that is capable of developing runoff hydrographs, routing hydrographs through channel reaches and reservoirs, and combining or separating hydrographs at confluences. Analyses of the hydraulic characteristics of flooding from the source studied were carried out to provide estimates of the elevations of floods of the 100-year recurrence interval. Both structural and nonstructural tools are used for achieving desired future flood plain conditions. There are three basic strategies which may be applied individually or in combination: (1) modifying the susceptibility to flood damage and disruption, (2) modifying the floods themselves, and (3) modifying (reducing) the adverse impacts of floods on the individual and the community. Information developed for this study will furnish a suitable basis for the adoption of land use controls to guide flood plain development. (Fish-PTT)
W91-03225

SUSQUEHANNA RIVER BASIN COMMISSION 1989 ANNUAL REPORT.
Susquehanna River Basin Commission, Harrisburg, PA.
For primary bibliographic entry see Field 6E.
W91-03243

6G. Ecologic Impact Of Water Development

EVALUATION OF FARMING SYSTEMS.
Agricultural Research Service, Lincoln, NE.
For primary bibliographic entry see Field 4C.
W91-02990

EFFECTIVE ENVIRONMENTAL ACTION: THE CASE OF THE WEKIVA RIVER.
Saint Johns River Water Management District, Palatka, FL. Dept. of Water Resources.
For primary bibliographic entry see Field 6E.
W91-03073

DESERT ENCROACHMENT IN EGYPT'S NILE VALLEY.
Minya Univ. (Egypt). Soil Science Dept.
For primary bibliographic entry see Field 2G.
W91-03120

EFFECTS OF GRAZING AND TRAMPLING ON SOIL DETERIORATION AROUND RECENTLY DRILLED WATER HOLES IN THE SAHELIAN ZONE.
Office de la Recherche Scientifique et Technique Outre-Mer, Abidjan (Ivory Coast).
For primary bibliographic entry see Field 4C.
W91-03122

IMPACT: AN EXPERT SYSTEM FOR ENVIRONMENTAL IMPACT ASSESSMENT.
Westinghouse Savannah River Co., Aiken,SC.
C. Loehle, and R. Osteen.
Available from the National Technical Information Service, Springfield, Virginia 22161, as DE89-010748. Price codes: A03 in paper copy, A01 in

microfiche. Report no. DP-MS--88-236, April 1989. 21 p, 2 fig, 1 tab, 25 ref, append. Contract no. DE-AC09-76SR00001.

Descriptors: *Computer models, *Computer programs, *Environmental impact, *Expert systems, *Model studies, Construction, Databases, Environmental policy, Land management, Land use, South Carolina.

Environmental assessment has become a routine part of the planning process for major development projects and land management activities, particularly within the federal government. An expert system screening tool provides the following advantages: (1) provides a standard, public procedure for all projects; (2) contains a complete list of environmental issues; (3) only requires data relevant to the proposed activity; and (4) acts as a training tool and source of expertise for novices. The model, developed at the Savannah River Site in South Carolina, is of the regulatory type, and is named IMPACT. It is designed to be a screening tool for construction projects and activities relative to compliance with NEPA (National Environmental Policy Act). It checks for a suite of possible environmental problems that might be caused by the activity. Activity types include well drilling, road construction, facility construction and operation, power line installation, and similar activities. Environmental issues include air and water emissions, sediment loading to streams, and groundwater contamination. Testing was carried out in stages. Feedback from potential users of the preliminary design and prototype led to redesign. The second stage prototype contained all goal functionality in the menus, but not all items were implemented and no report was generated. This testing was followed by development of the complete system. (Fish-PTT)
W91-03240

MODELLING THE EFFECTS OF PROPOSED PUMPING FROM THE TAMBRAPARNI RIVER BASIN, TAMILNADU, INDIA.
V.O.C. Coll., Tuticorin (India). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W91-03323

SALT MARSH MITIGATION: AN EXAMPLE OF THE PROCESS OF BALANCING MOSQUITO CONTROL, NATURAL RESOURCE, AND DEVELOPMENT INTERESTS.
Indian River Mosquito Control District, Vero Beach, FL.
P. D. O'Bryan, D. B. Carlson, and R. G. Gilmore.
Florida Scientist FLSCAQ, Vol. 53, No. 3, p 189-203, Summer 1990. 4 fig, 2 tab, 17 ref.

Descriptors: *Coastal marshes, *Florida, *Indian River Lagoon, *Land development, *Management planning, *Marsh management, *Mosquitoes, *Salt marshes, *Wetlands, Administrative agencies, Environmental effects, Mosquito control, Natural resources, Permits, Pine Island, Reservoirs, Salinity, Turbidity, Water quality monitoring, Wildlife habitats.

A Rotational Impoundment Management (RIM) plan was accepted by federal, state and local permitting agencies as mitigation for wetlands impacted during development of a riverfront subdivision at Indian River Impoundment number 6 (Pine Island, 129.5 ha). The developer submitted separate permit applications to the Florida Department of Environmental Regulation, St. John's River Water Management District, and Indian River County, each of which have jurisdiction for dredge and fill projects in salt marshes. Impoundment number 6 was seasonally re-integrated to the Indian River lagoon through culverts installed in the dike and water levels were carefully controlled with a permanent electric pump. Limited biological monitoring, as required by the permits, indicated that the impoundment responded positively to RIM. Fish and macrocrustacean sampling indicated increased species utilization of the marsh after re-connection to the estuary, and no negative effects on avian populations were observed during the dredging, filling and management activities. Salinity, turbidity, and temperature trends were comparable in the lagoon and in the impoundment. At no time during the closed period were permit regulations exceeded for salinity (>40 ppt), temperature (>35 C), or turbidity (>29 NTU over background). The project was considered to be beneficial to the private land owner, the local mosquito control district, and natural resource interests. (MacKeen-PTT)
W91-03441

COOPERATIVE AGREEMENT ON SETTLEMENT AND RESOURCE SYSTEMS ANALYSIS. PROCEEDINGS TO THE CONFERENCE ON THE AFRICAN EXPERIENCE WITH RIVER BASIN DEVELOPMENT: ACHIEVEMENTS TO DATE, THE ROLE OF INSTITUTIONS, AND STRATEGIES FOR THE FUTURE. HELD IN EASTON, MARYLAND ON MAY 24-27, 1988.
Clark Univ., Worcester, MA.
For primary bibliographic entry see Field 6B.
W91-03585

WATER QUALITY IMPACTS OF ILLINOIS RIVER COMMERCIAL NAVIGATION.
Illinois State Water Survey, Peoria. Water Quality Section.
For primary bibliographic entry see Field 5G.
W91-03610

WATERWAYS--THEIR RECREATIONAL POTENTIAL.
Heartland Water Resources Council, Peoria, IL.
For primary bibliographic entry see Field 6A.
W91-03612

COMMENTS FOR ILLINOIS RIVER CONFERENCE PEORIA, OCTOBER 3-4, 1989.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 5G.
W91-03613

ENVIRONMENTAL MANAGEMENT PROGRAM PROPOSALS: THE ILLINOIS BASIN.
Illinois State Dept. of Transportation, Springfield.
For primary bibliographic entry see Field 5G.
W91-03618

ILLINOIS RIVER BASIN: LIFEBLOOD OF OUR STATE.
Illinois Dept. of Energy and Natural Resources, Springfield.
K. A. Witter.
IN: Second Conference on the Management of the Illinois River System: The 1990s and Beyond. Proceedings of the Conference held October 3-4, 1989 in Peoria, Illinois. University of Illinois Water Resources Center Special Report No. 18, 1989. p 81-90.

Descriptors: *Ecological effects, *Illinois, *Illinois River Basin, *Water resources management, Economic aspects, Ecosystems, Fisheries, Illinois River, Lakes, Land use, Navigation, Recreation, Watershed management, Wildlife.

The Illinois River is 273 miles long, and the River Basin occupies about half of the land area of Illinois. The present-day Illinois River is a remnant of a much larger Mississippi River which carved out the Illinois Valley. The waterways of the Illinois River Basin carry 60% of the State's annual commodities tonnage. In addition to serving economic and commercial needs, the Illinois River also serves as the source for public water supply systems through a vast region of the state. The River is also home to a variety of fish populations, and side channels and backwaters serve as nurseries and spawning areas. In recent years as many as 375 bald eagles have been counted annually, representing about 3% of the total wintering population of bald eagles in the lower 48 states. In addition to fishing and hunting, the activities of boating, water skiing, hiking, and camping and the pleasures of the scenic and historic sites and parks along the river draw thousands of visitors to the banks of the Illinois each year. The most serious consequence to the health and welfare of the Illinois River is the problem of sedimentation. Although sedimentation has been a natural process through the ages, increased row-cropping and the construction of hydraulic structures has exacerbated the problem throughout the river basin. Sedimentation has been responsible for the disappearance of entire backwater lakes, and it has changed many portions of the river from lake-like expanses to narrow incised channels. Many of the backwater and bottomland lakes should no longer be called lakes; they are now really broad, shallow wetlands. In an effort to save these endangered lakes, the State Water Survey has developed some low-cost methods to restore aquatic vegetation. Scientists have also erected a breakwater in Peoria Lake to protect the planting area and to prevent further sedimentation. The new vegetation acts as a nursery for young bluegill, channel catfish, and bass, and actual numbers of fish have quadrupled since testing began. (See also W91-03608) (Lantz-PTT)
W91-03619

GEOLOGY FOR ENVIRONMENTAL PLANNING IN MONROE COUNTY, INDIANA.
Indiana Geological Survey, Bloomington.
E. J. Hartke, and H. H. Gray.
Available from the Publications Section, Indiana Geological Survey, 611 North Walnut Grove, Bloomington, IN 47405. Price: $6.00. Indiana Geological Survey Special Report 47, Environmental Study 21, 1989. 38p, 13 fig, 1 tab, 1 plate, 36 ref.

Descriptors: *Baseline studies, *Environmental protection, *Geology, *Indiana, *Land use, *Regional planning, *Water resources management, Geologic formations, Landfills, Minerals, Monroe County, Site selection, Water resources.

Monroe County, in south-central Indiana about 35 mi south of Indianapolis, is one of the most rapidly growing counties in Indiana. According to records maintained by the Indiana University gaging station, the average annual precipitation is about 44 in, which is spread relatively evenly throughout the year. Much spring and summer rain falls during thunderstorms, some of which bring damaging winds. Seasonal snowfall averages about 8 in per year, but much more may fall during a severe winter. Rapid growth in population (> 20% increase from 1972 to 1984) is placing great pressures on both agricultural and woodland resources. In addition, part of the county landscape has been effectively removed from beneficial use through crushed-stone and dimension-stone quarrying. The report is designed to present general information to planners, government officials, and the public to assist them in the orderly development and use of the natural mineral resources of Monroe County. It is not a definitive, detailed work but is a preliminary estimate of the land use suitability and mineral resources of the county. For example, the maps are approximations and the boundaries shown on them are gradational, but in nearly all areas more detailed information is available at the Indiana Geological Survey. Data sources for this study include field investigation, augur borings, seismic surveys, oil-and water-well logs, and published and unpublished reports. Information is presented concerning: mineral resources, water resources, disturbed areas, sanitary landfill suitability, septic system suitability, gas storage, natural features, and geologic hazards. (Lantz-PTT)
W91-03646

REASSESSING ESTIMATES OF GREAT LAKES CONSUMPTIVE USES AND IMPACTS.
Corps of Engineers, Chicago, IL. North Central Div.
For primary bibliographic entry see Field 6D.
W91-03676

CHICAGO AND ITS LAKEFRONT: LIVING ON THE EDGE.
Chicago Shoreline Protection Commission, IL.
H. L. Henderson, and N. Pansic.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 65-73, 4 fig, 2 tab.

Descriptors: *Chicago, *Environmental impact, *Great Lakes, *Lake management, *Lake shores, *Shore protection, *Water resources management, Cost-benefit analysis, Financial feasibility, History, Jurisdiction, Legal aspects, Metropolitan water management, Recreation, Social aspects, Urban planning, Water level, Water policy.

The deteriorating condition of Chicago's lakefront, as well as an assessment of potential remedial and enhancement measures, has been the subject of a year-long study by the Chicago Shoreline Protection Commission. This highly-developed, 30-mile stretch of urban shoreline is a key resource which contributes greatly to the quality of life of the residents of the largest metropolitan area on the Great Lakes. While the technical challenge of shore protection may be fairly well understood, Chicago's lakefront represents a complex mix of historical, jurisdictional, financial, legal, and social issues. These real-world issues must be taken into account if long-term shoreline protection is to be achieved in Chicago. The history of Chicago's lakefront begins in 1833, when a harbor and pier were constructed which started sediment erosion and accumulation patterns. The present shoreline was created between the world wars through sediment and debris fill activities, and is currently used for open parkland, harbors, beaches, private residences, and private industry. Steadily rising lake levels is a current cause for concern for protection of the shoreline as a public resource. Other technical issues which need to be addressed are: definition of 'normal' lake levels, wave climate, preference of 'hard' or 'soft' measures, and cost-effectiveness of designs. Fiscal constraints, funding priorities, governmental interrelations, and legal issues of shoreline ownership and development must all be considered in preservation and maintenance actions to be undertaken at Chicago's lakefront region. (See also W91-03672) (Fish-PTT)
W91-03679

ONTARIO HYDRO IMPACTS ON THE GREAT LAKES--AND VICE VERSA.
Ontario Hydro, Toronto.
C. W. Stevens.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 117-127, 6 fig, 3 ref.

Descriptors: *Diversion, *Great Lakes, *Hydroelectric plants, *Lake management, *Water level fluctuations, *Water resources management, Flood damage, Flow control, Hydrologic budget.

One important use of the water in the Great lakes system is the generation of electricity. As a major producer of electricity, Ontario Hydro a crown corporation owned by the atzens of Ontario has a vital stake in the future management of the Great Lakes system. Ontario Hydro diverts water into the Great Lakes system, and operates generating stations fed by the Welland Canal. Ontario Hydro, in conjunction with the New York Power Authority, operates generating stations on the St. Lawrence and on the Niagara River. Ontario Hydro operations have raised the levels of the Great Lakes by no more than 3 inches. When this increase is measured against storm surges of up to 8 feet, long-term variations of 5 feet, and record high levels of 3 feet above normal, the impact of the operations on flood damage is not significant. Closure of the diversions would slightly lower the lakes. However, the magnitude of this benefit in reducing flood damage would be no benefit because of the long time period required for the effect of changes to move through the system. The operation of the International Niagara River Control Structure does not appear to affect the discharge from Lake Erie. Hydroelectric generating stations are designed to use the most dependable flow in a river. As such, the stations on the Great Lakes system cannot use the extra water available during periods of high lake level. The excess water is spilled. The potential benefit of trying to remove Ontario Hydro impacts on the Great Lakes system by closing the diversions is far exceeded by the potential cost, both economic and environmental. (See also W91-03672) (Fish-PTT)
W91-03685

EFFECTS ON U.S. WATER RESOURCES OF AGRICULTURAL CHEMICALS AND RUNOFF: MAGNITUDE, EXTENT, AND ECONOMIC CONSEQUENCES.
Economic Research Service, Washington, DC.
S. R. Crutchfield.
IN: Nonpoint Pollution: 1988-Policy, Economy, Management, and Appropriate Technology. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 39-47, 9 ref.

Descriptors: *Agricultural chemicals, *Agricultural runoff, *Economic aspects, *Environmental effects, *Nonpoint pollution sources, *Water policy, *Water pollution control, *Water resources management, Environmental impact, Farm wastes, Groundwater pollution, Legislation, Nitrates, Pesticides, Public health, Surface-groundwater relations, Water pollution sources, Watershed management.

Agricultural nonpoint source pollution is a serious problem for U.S. water resources: the impact on water quality from agricultural residuals is broad in scope and geographically extensive. The primary problem is surface water and groundwater contamination by agricultural chemicals through leaching, rainwater runoff, or soil erosion. A recent study of groundwater in the U.S. estimated that about 1,400 counties (of 3,000 studied) showed the potential for either nitrate contamination, pesticide contamination, or both. Another study of freshwater systems showed that 48 of 90 watersheds were found to have excessive levels of nutrients or sediment caused by agriculture. For most types of water pollution, especially chronic conditions like excessive levels of nutrients and high concentrations of pesticides and other farm chemicals, the most significant coastal effects are usually found in estuaries and bays. The degradation of water quality from agricultural residuals results in an economic cost of several billion dollars annually. Three principal costs of groundwater contamination are health impacts, informational costs, and remedial costs. The social costs of human exposure to chemicals in groundwater are not yet known. A variety of federal, state, and local laws provide a legal or administrative basis for addressing the problem of agricultural nonpoint source pollution of surface and groundwater. Programs and policies to manage and control the impact of agriculture on U.S. water resources encompass many objectives and must involve tradeoffs among conflicting needs; the goals of environmental protection and enhancement of water quality may at times conflict with other social goals such as ensuring profitable food and fiber production. (See also W91-03704) (Fish-PTT)
W91-03709

BIODIVERSITY LOSS IN THE TEMPERATE ZONE: DECLINE OF THE NATIVE FISH FAUNA OF CALIFORNIA.
California Univ., Davis. Dept. of Wildlife and Fisheries Biology.
P. B. Moyle, and J. E. Williams.
Conservation Biology, Vol. 4, No. 3, p 275-284, September 1990. 2 fig, 3 tab, 32 ref, append.

Descriptors: *California, *Ecological effects, *Environmental impact, *Fish populations, *Species diversity, Ecosystems, Fish establishment, Habitats, Stress, Water resources development.

In proportion to the entire fauna, loss of species may be as great in temperate regions as in tropical regions. To test the validity of this statement an investigation was conducted concerning the status of the native fish fauna of California, using a methodology that quantifies expert knowledge. Of 113 native taxa, 6% are extinct, 12% are officially listed as threatened or endangered, 6% deserve immediate listing, 17% may need listing soon, 22% show declining populations but are not yet in serious trouble, and 36% appear to be secure. Much of the faunal decline has taken place in recent years; it has included unexpectedly rapid declines of once abundant species. Fish taxa in serious trouble are most likely to be: (1) endemic to California, (2) restricted to small areas, (3) occupants of just one drainage basin, (4) part of a fish assemblage of less than 5 species, and (5) found in isolated springs, warm water streams, or big rivers. Water diversions and introduced species, acting in concert, seem to be the principal causes of the decline of the native fauna, although other types of habitat degradation have contributed as well. The situation in California with its high degree of endemism (60%), may be regarded as extreme but fish faunas in other temperate regions show signs of being nearly as stressed. It is likely that the situation with fish reflects a more general decline in the biota of temperate regions of the world. (Author's abstract)
W91-03870

COLLAPSE OF RIPARIAN POPLAR FORESTS DOWNSTREAM FROM DAMS IN WESTERN PRAIRIES: PROBABLE CAUSES AND PROSPECTS FOR MITIGATION.
Lethbridge Univ. (Alberta). Dept. of Biological Sciences.
S. B. Rood, and J. M. Mahoney.
Environmental Management EMNGDC, Vol. 14, No. 4, p 451-464, 1990. 4 fig, 2 tab, 54 ref.

Descriptors: *Dam effects, *Ecological effects, *Environmental policy, *Poplar trees, *Riparian vegetation, Alberta, Arizona, Colorado, Drought, Flooding, Forests, Land use, North Dakota, Restoration, Streamflow, Water resources development, Wyoming.

The riparian poplar forests of the western prairies are endangered as a result of the damming and diversion of rivers in this region. Recent reports have described substantial declines of riparian poplar forests downstream from dams in Alberta, Montana, North Dakota, Wyoming, Colorado, and Arizona. Forest and hydrological conditions are analyzed to clarify the causes of downstream forest decline. Dams were found to contribute to forest failure by: (1) reducing downstream flows; and/or (2) altering flow patterns to attenuate spring flooding and/or stabilize summer flows. Reduced flows are reported to induce drought stress, which is particularly lethal to seedlings and very old poplars. The artificial moderation of spring flooding may inhibit the formation of seedbeds essential for seeding replenishment. Increased river valley development involving cattle grazing, agricultural clearing and direct harvesting of trees also contributes to forest failure. Potential methods of mitigating the impacts of dams on downstream forests include downstream flow schedules that: (1) retain occasional spring flooding, (2) taper off rather than abruptly drop downstream flow, and (3) provide adequate flows throughout the summer. Poplar forest stabilization and recovery can be further promoted by fencing to protect trees from livestock grazing and trampling, or artificial site preparation such as cultivation or scarification to encourage poplar regeneration. (Author's abstract)
W91-03876

SALINE SEEPAGE AND LAND DEGRADATION--A NEW SOUTH WALES PERSPECTIVE.
Soil Conservation Service of New South Wales, Sydney (Australia).
For primary bibliographic entry see Field 5B.
W91-03893

7. RESOURCES DATA

7A. Network Design

CONSIDERATIONS FOR DATA COLLECTION TO SUPPORT SIMULATION ANALYSES IN THE SATURATED ZONE.
D. W. Pollock.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 43-44.

Descriptors: *Groundwater data, *Hydrologic data collections, *Hydrologic models, *Model studies, *Nonpoint pollution sources, *Water pol-

lution control, Data requirements, Simulation analysis.

Simulation has been an integral part of groundwater science for over half a century. Models are useful because they provide a systematic framework for integrating and evaluating the effects of the many interacting processes that control the behavior of groundwater systems. A critical point has been reached where a careful look must be taken at the capabilities of models and the relation between simulation, data collection, and the objectives that drive groundwater studies. Successful studies involve an iterative approach to problem-solving that consists of: (1) definition of the problem and objectives, (2) development of a conceptual model, or set of working hypotheses about how the groundwater system functions, (3) an analysis of existing data, (4) collection of new data that is appropriate to address the problem, (5) further analysis, often based around simulation, and (6) re-evaluation of conceptual models and the possible need for additional data and analysis. This type of iterative approach requires that the collection of hydrogeologic data be interwoven with and inseparable from the analysis of the problem. Data collection programs designed without specific objectives in mind often fail to meet the needs of specific problems when they arise. (See also W91-02985) (Fish-PTT)
W91-02994

40 CFR 265 INTERIM STATUS INDICATOR-EVALUATION GROUND-WATER MONITORING PLAN FOR THE 216-B-63 TRENCH.
Battelle Pacific Northwest Labs., Richland, WA.
B. N. Bjornstad, and S. Dudziak.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-012583. Price codes: A07 in paper copy, A01 in microfiche. Report No. PNL-6862, March 1989. 140p, 15 fig, 12 tab, 50 ref, 3 append.

Descriptors: *Groundwater quality, *Hanford Site, *Hazardous wastes, *Monitoring, *Monitoring wells, *Network design, *Project planning, Groundwater pollution, Leaching, Path of pollutants, Washington.

An outline of a groundwater monitoring plan for the 216-B-63 trench located in the northeast corner of the 200 East Area on the Hanford Site in southeastern Washington State is presented. It was determined that hazardous materials (corrosives) were disposed of into the trench during past operations. Installation of an interim-status groundwater monitoring system is required to determine whether hazardous chemicals are leaching to the groundwater from beneath the trench. This document summarizes the existing data that are available from near the 216-8-63 trench and presents a plan to determine the extent of groundwater contamination, if any, derived from the trench. The plan calls for the installation of four new monitoring wells located near the west end of the trench. These wells will be used to monitor groundwater levels and water quality immediately adjacent to the trench. Two existing Resource Conservation and Recovery Act monitoring wells, which are located near the trench and hydraulically upgradient of it, will be used as background wells. (Lantz-PTT)
W91-03024

MINIMUM SET OF DATA ELEMENTS FOR GROUND WATER.
Environmental Protection Agency, Washington, DC. Information Management and Services Div.
M. Zenon, N. Dee, and C. Miller.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 3A-5--3A-15, 4 tab, 2 ref.

Descriptors: *Data requirements, *Data storage and retrieval, *Databases, *Groundwater resources, *Information systems, *Network design, *Water management, Geohydrology, Information exchange, Springs, Wells.

The EPA is considering the adoption of a policy which requires the creation and maintenance of a consistent collection of groundwater data based on a minimum set of data elements. The set of data elements was selected by a work group made up of representatives from EPA, other Federal agencies and the States. The set is characterized by elements that are needed to: communicate groundwater data across programs; facilitate accessing data from automated information systems other than one's own; provide, to the users, a road map for finding other related material; and, provide a link between water quality and well location information. The set consists of 22 elements, including geographic descriptors, well/spring descriptors and sample descriptors. Individual programs can add elements to this base to meet their special program needs: EPA encourages the groundwater community to adopt this minimum set as the collection of a consistent set of data elements will lead to more efficient management and sharing of data across the groundwater community, and ultimately to better decision-making. (See also W91-03032) (Author's abstract)
W91-03044

GROUND WATER MODELING ANALYSIS FOR A CONTAMINATED WATER-SUPPLY WELL FIELD IN INDIANA.
Weston (Roy F.), Inc., West Chester, PA.
For primary bibliographic entry see Field 2F.
W91-03081

GEOHYDROLOGICAL DATA ACQUISITION: SOME IMPERATIVES.
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 2F.
W91-03188

GROUND WATER MONITORING AT WELLHEAD PROTECTION AREAS.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W91-03447

METHODS DEVELOPMENT AND IMPLEMENTATION FOR THE NATIONAL PESTICIDE SURVEY.
Environmental Protection Agency, Cincinnati, OH.
For primary bibliographic entry see Field 5A.
W91-03507

SAMPLING ERRORS FOR RAINGAUGE-DERIVED MEAN AREAL DAILY AND MONTHLY RAINFALL.
Hydrological Research Inst., Pretoria (South Africa).
For primary bibliographic entry see Field 2B.
W91-03746

7B. Data Acquisition

RESULTS OF QUALIFICATION TESTS ON WATER-LEVEL SENSING INSTRUMENTS, 1987.
Geological Survey, Stennis Space Center, MS. Water Resources Div.
T. E. Olive.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-397, 1990. 37p, 8 fig, 11 tab, 9 ref, append. Project no. WD954.

Descriptors: *Data acquisition, *Instrumentation, *Performance evaluation, *Water level, *Water measurement, Procurement, Qualified products list, Test facilities.

The U.S. Geological Survey's Hydrologic Instrumentation Facility at the Stennis Space Center, Mississippi, conducts qualification tests on water level sensing instruments. Instrument systems, which meet or exceed the Survey's minimum performance requirements, are placed on the Survey's Qualified Products List. The qualification tests conducted in 1987 added two instrument systems to the Survey's Qualified Products List. One system met requirements for use at a daily-discharge station, and the other system met requirements for a special-case station. The report is prepared for users of hydrologic instruments. The report provides a list of instrument features, describes the instrument systems, summarizes test procedures, and presents test results for the two instrument systems that met the Survey's minimum performance standards for the 1987 round of qualification tests. (USGS)
W91-02966

WATER-RESOURCES PROGRAMS AND HYDROLOGIC-INFORMATION NEEDS, MARION COUNTY, INDIANA, 1987.
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 6A.
W91-02967

QADATA USER'S MANUAL: AN INTERACTIVE COMPUTER PROGRAM FOR THE RETRIEVAL AND ANALYSIS OF THE RESULTS FROM THE EXTERNAL BLIND SAMPLE QUALITY-ASSURANCE PROJECT OF THE U.S. GEOLOGICAL SURVEY.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-02981

SAN FRANCISCO CENTRAL BAY SUSPENDED SEDIMENT MOVEMENT. REPORT 1: SUMMER CONDITION DATA COLLECTION PROGRAM AND NUMERICAL MODEL VERIFICATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 2J.
W91-03010

MAPPING RIPARIAN/WETLAND HABITATS OF THE NEZ PERCE NATIONAL FOREST. A COOPERATIVE APPROACH.
Fish and Wildlife Service, Portland, OR.
B. V. Harrison, and G. F. Kellogg.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 6A-15--6A-23, 1 fig, 16 ref.

Descriptors: *Data acquisition, *Mapping, *Nez Perce National Forest, *Riparian land, *Water management, *Water resources management, *Wetlands, Classification, Economic aspects, Interagency cooperation, Riparian waters, Surveys, Water resources data.

The US Forest Service has a long standing policy to recognize the unique values of riparian areas (riparian ecosystems, aquatic ecosystems, wetlands and flood plains) and to manage these areas in relation to various legally mandated requirements. The Nez Perce National Forest decided to inventory all riparian areas with the Forest in order to facilitate the management of activities which could potentially impact these riparian and wetland resources. After consulting with the US Fish and Wildlife Service's (USFWS) National Wetlands Inventory program, the Nez Perce decided to map all riparian/wetland resources in the Forest using the USFWS's wetland classification system. A cooperative agreement was struck when the Nez Perce and National Wetlands Inventory decided to fund different phases of the inventory independently. Wetland maps depicting riparian/wetland location, shape and type were prepared for the entire Forest. This cooperative effort resulted in reduced inventory costs for both agencies. (See also W91-03032) (Author's abstract)
W91-03050

METHOD FOR COMPUTING SHEETFLOW RUNOFF FOR FLAT SLOPES.
South Florida Water Management District, West Palm Beach. Dept. of Resource Management.

R. S. Tomasello, and N. L. Garrido.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 9A-5--9A-12, 4 fig, 4 ref.

Descriptors: *Data interpretation, *Flood routing, *Florida, *Model studies, *Rainfall-runoff relationships, *Routing, *Runoff, *Sheet flow, Computer models, Hydrologic models, Runoff rates, Surface runoff, Water resources management.

Where specific basin discharge criteria have not been developed, the South Florida Water Management District's (SFWMD) surface water management program requires post development design discharges to be less than or equal to the predevelopment runoff rates. An accurate means of estimating the design storm predevelopment runoff rate is important to the water management system design, and to the integrity of the receiving waters. An over estimate of predevelopment runoff rates may lead to basin flooding problems. On the other hand, an underestimate may lead to an expensive overdesign of the water management system and the loss of developable land. Traditional hydrologic runoff methods generally do not provide good results for routing in very flat basins, particularly where back water effects and tailwater conditions are important. Natural systems incorporating wetland sloughs and heads are examples of such systems. The SHEET2D model has been developed which provides the user with the ability to dynamically route excess rainfall as overland flow through flat areas, including wetlands. The model utilizes hydrologic methods to compute the excess rainfall and uses hydraulic/hydrodynamic computations for the overland routing. The results of model verifications, particularly in wetland areas, are presented. The SHEET2D model and its upfront program will offer a user friendly environment to SFWMD permitting engineers and reviewers to apply a more sophisticated methodology for flood routing design storms in sheetflow conditions. The SHEET2D model employs the dynamic equations allowing for accurate physical simulations of water movement in the flat slope conditions not available through traditional hydrologic methods. (See also W91-03032) (Lantz-PTT)
W91-03065

INCREASING THE VALUE OF TECHNICAL DATA FOR MAKING GROUNDWATER POLICY DECISIONS.
North Carolina State Univ., Raleigh. Dept. of Economics.
L. E. Danielson, G. Meij, and C. W. Abdalla.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 10B-15--10B-22, 10 ref.

Descriptors: *Data acquisition, *Groundwater management, *Groundwater resources, *Water resources data, *Water resources management, Decision making, Interagency cooperation, Local governments, Public policy, State jurisdiction.

Water quality program funding is heavily oriented toward collection of data and research and development activities, especially in the early stages of issue development. Making data available to policy makers in a useful form and in a timely manner increases the value of the information. Ways to increase the value of technical groundwater data are considered. Coordination between policy makers and data collection agencies increases the value of the technical data and improves policy decision making. It is difficult for federal agencies to determine specific data and information needs at state and local levels. It is also more difficult for local decision makers to access and interpret technical data than for agencies and individuals generating the data. Increasing cooperation between agencies is seen as the key to providing the ability to make sound groundwater policy decisions. (See also W91-03032) (Lantz-PTT)
W91-03075

MONITORING POPULATIONS OF 4-CHLOROBIPHENYL-DEGRADING BACTERIA IN SOIL AND LAKE WATER MICROCOSMS USING COLONY HYBRIDIZATION.
Tennessee Univ., Knoxville.
For primary bibliographic entry see Field 5G.
W91-03114

USE OF SOIL SPECTRAL PROPERTIES FOR MONITORING SOIL EROSION.
Maryland Univ., College Park. Dept. of Agronomy.
R. A. Weissmiller, G. E. Van Scoyoc, S. E. Pazar, K. Latz, and M. F. Baumgardner.
IN: Soil Erosion and Conservation. Soil Conservation Society of America, Ankeny, Iowa. 1985. p 119-127, 6 fig, 2 tab, 13 ref.

Descriptors: *Monitoring, *Remote sensing, *Soil erosion, *Soil physical properties, *Soil spectral properties, Indiana, Iron oxides, Satellite technology, Soil classification, Soil conservation.

The universal soil loss equation has proved useful for predicting erosion and planning conservation. To reduce staggering topsoil losses and to maintain agricultural productivity, methods must be developed to assess, delineate, and monitor soil erosion rapidly and accurately. Remote sensing techniques, such as black and white aerial photography have been used in soil survey work for years. More recently, Landsat satellite data have been used as an aid in soil survey for both small-scale and more detailed inventories. While working in the midwestern United States to develop digital analysis techniques for using Landsat multispectral scanner (MSS) data to aid in the soil survey effort, researchers found that these techniques also offered a potential means of quantitatively surveying and measuring areas of severely eroded soils. Several workers have used spectral qualities of soils to distinguish and classify eroded surface soils in parts of Indiana. As iron oxide content increases and organic matter content decreases with increased severity of erosion, reflectance properties of soils change. However, severely eroded soils show decreased reflectance, so that the highest reflectance may not represent the most severely eroded soils. The capability to detect severely eroded soils while preparing a soil inventory of Jasper County, Indiana, was a significant breakthrough in the use of digital analysis of Landsat MSS data to assess degradation of land resources. (See also W91-03117) (Rochester-PTT)
W91-03128

DESIGN AND CONSTRUCTION CONSIDERATIONS FOR SEDIMENT SAMPLING OF STREAMFLOWS.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 2J.
W91-03130

PROGRESS AND PROSPECTS IN ENVIRONMENTAL ISOTOPE HYDROLOGY.
Niedersaechsisches Landesamt fuer Bodenforschung, Hanover (Germany, F.R.)
For primary bibliographic entry see Field 2F.
W91-03180

EXPLORATION OF FRACTURED ZONES BY RADON DETERMINATION IN THE SOIL.
For primary bibliographic entry see Field 2G.
W91-03181

GEOHYDROLOGICAL DATA ACQUISITION: SOME IMPERATIVES.
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 2F.
W91-03188

STRUCTURE OF TROPICAL CYCLONES AND SURROUNDING REGIONS AS DETERMINED FROM OLS AND SSM/I IMAGERY ANALYSIS.
Air Force Geophysics Lab., Hanscom AFB, MA.
For primary bibliographic entry see Field 2B.
W91-03226

40 CFR 265 INTERIM-STATUS GROUNDWATER MONITORING PLAN FOR THE 2101-M POND.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5A.
W91-03238

SEQUENTIAL PRECIPITATION SAMPLERS: A LITERATURE REVIEW.
Nebraska Univ. at Omaha. Dept. of Chemistry.
For primary bibliographic entry see Field 2B.
W91-03294

INTERCOMPARISON OF CONTINUOUS FLOW, AND AUTOMATICALLY SEGMENTING RAINWATER COLLECTION METHODS FOR DETERMINING PRECIPITATION CONDUCTIVITY AND PH.
Nebraska Univ. at Omaha. Dept. of Chemistry.
For primary bibliographic entry see Field 2B.
W91-03295

DETERMINATION OF ANISOTROPIC PERMEABILITY OF AN UNCONFINED AQUIFER IN EGYPT USING PUMPING TEST DATA OF A PARTIALLY PENETRATING WELL.
International Inst. for Hydraulic and Environmental Engineering, Delft (Netherlands).
M. Shahin.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Proceedings of an International Workshop held February 28-March 4, 1989. This is Volume 2 of a 3 Volume Set. A. A. Balkema, Brookfield, Vermont. 1989. p 569-579, 7 fig, 7 ref.

Descriptors: *Aquifer testing, *Aquifers, *Egypt, *Groundwater movement, *Pumping tests, *Wells, Anisotropy, Comparison studies, Mathematical models, Nile Delta, Performance evaluation, Permeability.

Wells installed for pumping groundwater in Egypt have short screens that do not penetrate the full thickness of the aquifer. Consequently, the results obtained from pumping tests often are considered uncertain because field conditions generally do not agree with the assumptions of the traditional analysis. The vertical component of groundwater flow to a pumped well partially penetrating an aquifer should be considered in the analysis and not ignored. A pumped well at Abu-Shalaby (Nile Delta) was employed for some tests of recent techniques for analyzing pumping test data, in which anisotropy of the aquifer is considered. The results were compared to those obtained with traditional methods. Methods based on the grain-size distribution of the aquifer material are too empirical. Unless proper constants are used, the results could be misleading. The methods based on the anisotropy of the aquifer material, where both horizontal and vertical permeabilities are considered, seem to give more realistic and satisfactory results. The two steady-state methods (RIGW/IWACO and a similar one with a different type curve), in which the drawdown is measured in one in vertical section and in the other in a horizontal section, give almost the same values, especially for the horizontal permeability the horizontal permeability. The unsteady-state method give slightly high values for the horizontal permeability and the vertical permeabilit. To overcome the differences among the various methods, the use of average results from all the methods should be used. (See also W91-03311) (Rochester-PTT)
W91-03318

SELECTING EFFECTIVE METHODS FOR GROUNDWATER PROSPECTING AND EXPLORATION IN MEKONG DELTA.
General Department of Mine and Geology, S. R. Vietnam.
For primary bibliographic entry see Field 2F.
W91-03333

CASE STUDY OF INTEGRATED EXPLORATION PRACTICE FOR SHALLOW FRESH WATER AQUIFERS IN SOUTHERN PARTS OF RAMNAD DISTRICT (TECHNOLOGY MISSION PROJECT).
AFPRO GIT Unit III, Coimbatore.
For primary bibliographic entry see Field 2F.
W91-03351

DETERMINATION OF URANIUM IN AN ANALYTICAL CHEMISTRY LABORATORY.
Environmental Monitoring Systems Lab., Las Vegas, NV.
C. K. Liu, R. W. Holloway, and J. Akridge.
IN: Radon, Radium and Uranium in Drinking Water. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 165-171. 8 ref.

Descriptors: *Analytical techniques, *Chemical analysis, *Laboratory methods, *Pollutant identification, *Radioactivity techniques, *Radiochemical analysis, *Radioisotopes, *Uranium, *Water analysis, Alpha spectroscopy, Drinking water, Fluorometry, Quantitative analysis, Resins, Spectroscopy, Water quality standards.

Three methods for the analysis of uranium in water are commonly used by laboratories involved in measuring radioactivity in the environment: (1) alpha spectroscopy, (2) radiochemical separation and total alpha particle counting, and (3) fluorometry. Of these, the fluorometric method measures the total mass of uranium and not the uranium radioactivity. The radioactivity of uranium must be inferred from this measurement, based on some assumption concerning the ratio of U-234 to U-238. Because this ratio may be highly variable in natural water, the fluorometric method will often be less accurate than the other two methods in assessing the radioactivity of uranium in water. This is especially true in cases where most of the radioactivity is due to U-234 rather than U-238. For those laboratories unable to acquire alpha spectroscopy instruments, the radiochemical separation/alpha particle counting method is an acceptable alternative. However, the need to estimate the chemical recovery in this method is a weakness of some importance. The most suitable method for the measurement of uranium in drinking water is the method using alpha spectroscopy. This allows the accurate measurement of the alpha activity of each isotope of uranium. There are a number of different purification schemes that will produce pure samples in a form that can be counted by alpha spectroscopy. One of the most popular methods is the use of ion exchange resins. Based on the analytical merits of alpha spectroscopy it should be the method of choice for the measurement of uranium in drinking water. (See also W91-03366) (Agostine-PTT)
W91-03376

SETTING UP A LABORATORY FOR RADON IN WATER MEASUREMENTS.
Maine Univ. at Orono. Dept. of Physics and Astronomy.
For primary bibliographic entry see Field 5A.
W91-03378

ANALYTICAL METHODOLOGY FOR RADIUM IN FOOD AND WATER.
Food and Drug Administration, Winchester, MA. Winchester Engineering and Analytical Center.
For primary bibliographic entry see Field 5A.
W91-03379

PRECONCENTRATION OF IRON BY COMPLEXATION AND ULTRAFILTRATION.
Turin Univ. (Italy). Dipt. di Chimica Analitica.
C. Sarzanini, P. Masse, E. Mentasti, and A. Verdier.
Separation Science and Technology SSTEDS, Vol. 25, No. 6, p 729-737, May 1990. 4 tab, 18 ref.

Descriptors: *Chemical analysis, *Iron, *Pollutant identification, *Ultrafiltration, *Water analysis, Hydrogen ion concentration, Ion exchange, Polyelectrolytes.

The effect of a cationic polyelectrolyte (Multifloc C563, Protex) on the formation of complexes of iron and 1,2-dihydroxybenzene-3,5-disulfonic acid (Tiron) and the behavior of such complexes in ultrafiltration experiments were investigated. Discontinuous ultrafiltration experiments were performed with neutral membranes, and metal-ligand, ligand C563, and metal-ligand-C563 systems. The first set of experiments was performed to evaluate the efficiency of ultrafiltration with respect to the stoichiometry of the iron-Tiron complexes (Fe-T, Fe-T2, and Fe-T3). At pH 2 there was a release of the complex and a poor recovery of iron (46%). At pH 9, the larger steric hindrance provided a greater interaction with the membrane and a higher recovery of iron (77%). The presence of polyelectrolyte improved iron retention, so that 50 and 95% of Fe(III) was recovered at pH 2 and 9, respectively. Because the concentration of polyelectrolyte in the permeate and in the retentate may become a limiting parameter, ultrafiltrations were performed to evaluate its behavior. The permeate and retentate concentrations of polyelectrolyte were the same in the corresponding fractions for all the conditions considered and did not significantly affect the ultrafiltration performance. The present preconcentration method may be useful for reducing the detection limits of heavy metals, reducing matrix interference in instrumental determinations, and removing toxic metals from polluted waters. (Geiger-PTT)
W91-03411

INSENSITIVITY OF REMOTE SENSING TO WATER-LOGGING IN LOW-CAPILLARITY SOILS.
Punjab State Council for Science and Technology, Chandigarh (India).
K. P. Singh.
Current Science CUSCAM, Vol. 59, No. 9, p 464-465, 1990. 7 ref.

Descriptors: *Capillarity, *India, *Landsat images, *Remote sensing, *Soil water, *Waterlogging, Field tests, Flood plains, Land reclamation, Mapping, Monitoring, Project planning.

Use of Landsat data has been reported widely for monitoring waterlogging patterns. Examples of various case studies indicate that such techniques, though extremely useful, should essentially be used in conjunction with field data. It is demonstrated that in certain cases, although the area may be waterlogged, Landsat images may not register any signatures. Such observations when interpreted without the aid of field data lead to deceptive results and wrong planning and execution of schemes in the field for reclamation of waterlogged areas. Examples from the alluvial tracts of Punjab State, India, highlight the importance of such data. Waterlogged areas generally appear to have different spectral signatures on Landsat images due to the increased moisture content in the topsoils. Waterlogged areas can be picked up by Landsat and Thematic Mapper data if the capillary rise in the soils is high and the topsoil zone is near saturation. Field visits have proved that even though an area is waterlogged, it may not appear on Landsat and TM data products. Recommended measures include construction of new surface, link, and subsurface drains; lining of canals and distributaries; introduction of vertical drainage, afforestation measures, etc. and aim to decrease the inflow components and increase the outflow components in the groundwater system. (Fish-PTT)
W91-03418

MEMBRANE/GAS CHROMATOGRAPHIC SYSTEM FOR AUTOMATED EXTRACTION AND DETERMINATION OF TRACE ORGANICS IN AQUEOUS SAMPLES.
Dow Chemical Co., Midland, MI. Analytical Labs.
For primary bibliographic entry see Field 5A.
W91-03436

FIELD METHODS FOR MEASUREMENT OF GROUND WATER REDOX CHEMICAL PARAMETERS.
Geological Survey, Denver, CO. Geologic Div.
K. Walton-Day, D. L. Macalady, M. H. Brooks, and V. T. Tate.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 4, p 81-89, Fall 1990. 5 fig, 2 tab, 40 ref.

Descriptors: *Analytical methods, *Geochemistry, *Groundwater chemistry, *Oxidation-reduction potential, *Water analysis, *Water chemistry, *Water sampling, Cape Cod, Colorado, Field tests, Groundwater pollution, Ion-selective electrodes, Massachusetts, Tennessee Park, Water quality monitoring.

An inexpensive, versatile, and portable system for rapid field determinations of redox potentials, pH, conductivity, ferrous and total iron, nitrite, specific conductance, dissolved oxygen, and temperature of groundwater is described. Three airtight flow-through cells were designed and constructed to permit flow of groundwater into and through the cells with minimal infiltration of atmospheric gases into the samples. The electrode flow-through cell permits simultaneous use of up to four electrodes. The ampoule flow-through cell is used for commercially available colorimetric analyses for many dissolved constituents. The sample collection cell is designed to provide samples that are unaffected by outgassing and contact with atmospheric gases. A portable mounting scheme facilitates routine sampling of multiple wells. Analytical determinations in the field were generally performed with commercially available ampoules, prepared analytical kits, or standard field instruments. The field apparatus and associated analyses were applied to two field sites. Analysis of a shallow sand and gravel aquifer contaminated with treated sewage on Cape Cod, Massachusetts indicated detectable levels of dissolved oxygen in all samples except those containing ferrous iron. The findings support the hypotheses of denitrification and Nernstian response of platinum electrodes. The second site, a subalpine wetland in Tennessee Park near Leadville, Colorado, receives input from a stream contaminated with acid mine drainage. The wide range of iron, oxygen, and sulfide concentrations, despite the close proximity of the wells, is evidence of the pervasive chemical heterogeneity of the aquifer with respect to redox-sensitive aqueous species. It is concluded that the field methods described provide the means for rapid and reliable analyses of groundwater geochemical parameters. (MacKeen-PTT)
W91-03444

COMPLEMENTARY INVESTIGATIVE TECHNIQUES FOR SITE ASSESSMENT WITH LOW-LEVEL CONTAMINANTS.
Science Applications International Corp., Golden, CO. Environmental Remediation Div.
For primary bibliographic entry see Field 5G.
W91-03445

SOIL-GAS SURVEYING FOR SUBSURFACE GASOLINE CONTAMINATION USING TOTAL ORGANIC VAPOR DETECTION INSTRUMENTS: PART II. FIELD EXPERIMENTATION.
Connecticut Univ., Storrs. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 5A.
W91-03448

DEVELOPMENT AND APPLICATION OF A TECHNIQUE FOR ESTIMATING NUTRIENT DEFICIENCY IN SOFT SEDIMENTS.
Montana State Univ., Bozeman. Dept. of Biology.
W. K. Dodds, and J. C. Priscu.
Hydrobiologia HYDRB8, Vol. 203, No. 1/2, p 93-97, September 14, 1990. 2 fig, 19 ref.

Descriptors: *Analytical techniques, *Diffusion, *Enrichment, *Lake sediments, *Limiting nutrients, *Limnology, *Nutrient concentrations, *Sediment analysis, *Sediment sampler, Benthic environment, Estimating, Nitrates, Nitrogen, Oligotrophic lakes, Oxygen, Phosphates, Phosphorus, Photosynthesis, Primary productivity, Water sampling.

A diffusion enrichment technique has been developed which allows for chemical enrichment of soft surficial and shallow subsurface sediments and subsequent measurement of O2 production. The sediment is enriched by inserting a perforated tube containing dialysis tubing filled with a nutrient/agar mixture. O2 production by surficial sediment is measured using an inverted, translucent, polyethylene chamber over the sediment. The inside of the chamber contains a collapsible bag connected to the water outside the chamber. When water overlying the sediment is withdrawn from a sampling port, it is displaced with water from outside the chamber, thus preventing contamination of water samples with pore water from below. The technique was tested by enriching near-shore sediments in a large oligotrophic lake with inorganic N and P. NH4(+) additions significantly stimulated benthic primary production as measured by O2 production, whereas enrichment with PO4(-3) had no effect. (Author's abstract)
W91-03499

DYNAMIC PARTITIONING OF ORGANIC CHEMICALS IN REGIONAL ENVIRONMENTS: A MULTIMEDIA SCREENING-LEVEL MODELING APPROACH.
California Univ., Los Angeles. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W91-03510

EIGHT-MONTH SAMPLE OF MARINE STRATOCUMULUS CLOUD FRACTION, ALBEDO, AND INTEGRATED LIQUID WATER.
Pennsylvania State Univ., University Park. Dept. of Meteorology.
For primary bibliographic entry see Field 2B.
W91-03524

CANCER RISK ASSESSMENT: IMPORTANCE OF IDENTIFYING MECHANISMS OF ACTION.
Washington State Univ., Pullman. Coll. of Pharmacy.
R. J. Bull.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 10, p 57-60, October 1990. 2 tab, 16 ref.

Descriptors: *Carcinogens, *Drinking water, *Mathematical models, *Public health, *Risk assessment, *Water treatment, Contaminants, Health aspects, Public policy, Water quality standards.

The goal of risk assessment is to estimate the likelihood of adverse human health effects that could result from exposure to potentially hazardous substances or activities. The process by which regulatory standards are established for drinking water contaminants is based on extrapolating animal toxicity data to humans using a standard mathematical model. The assumptions and judgements involved introduce a relatively high degree of uncertainty and conservativeness into both the qualitative and quantitative aspects of the process. The practical effect is that standards developed under the current regulatory process are based on inflated estimates of the actual calculated risks. Setting standards based on knowledge of specific mechanisms of carcinogenicity would decrease the uncertainty involved in risk assessment. If the process were to take into account the carcinogenic mechanisms of specific contaminants rather than treat all contaminants the same, the resulting standards could differ by orders of magnitude. Understanding these specific mechanisms of carcinogenicity is necessary for arriving at the most appropriate mathematical construct for calculating more rational standards. (Mertz-PTT)
W91-03529

SATELLITE DATA TRANSMISSION AND HYDROLOGICAL FORECASTING IN THE FIGHT AGAINST ONCHOCERCIASIS IN WEST AFRICA.
Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Abidjan (Ivory Coast). Centre ORSTOM d'Adiopodoume.
E. Servat, J.-M. Lapetite, J.-C. Bader, and J.-F. Boyer.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 187-198, September 1990. 5 fig, 9 ref.

Descriptors: *Data transmission, *Flow discharge, *Human diseases, *Hydrologic data, *Public health, *River forecasting, *Satellite technology, *West Africa, Computer programs, Data acquisition, Insecticide application, Surface water data, Water level.

Onchocerciasis, or river blindness, is an endemic disease which causes great hardship in west Africa. Within the World Health Organization's Onchocerciasis Control Program (WHO/OCP), reliable data on the discharge of the watercourses have been obtained by using remote satellite transmission. These data are necessary to calculate how much insecticide should be introduced into the rivers. The hydrological platform consists of a system for measuring water level using a pressure sensor powered by a solar panel and a battery. Measurements are made every 30 min and transmitted by satellite to a reception station. The technique offers several advantages: (1) guaranteed access to data in all seasons; (2) transmission of the water levels almost in real-time; (3) more reliable data than that from river gauges; and (4) rapid and simple centralization of the data. Implementation of the system has resulted in improved efficiency of treatment and in the reduction of OCP costs. Software for forecasting the discharge over different time intervals was developed to improve the efficiency of the system. Satellite transmission of hydrologic data is recommended for other applications, including flood warning systems and management of national hydrologic networks. (MacKeen-PTT)
W91-03548

METHODS FOR THE DETERMINATION OF ORGANIC COMPOUNDS IN DRINKING WATER.
Environmental Monitoring Systems Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5A.
W91-03580

EVALUATION OF TREND DETECTION TECHNIQUES FOR USE IN WATER QUALITY MONITORING PROGRAMS.
Colorado State Univ., Fort Collins.
J. C. Loftis, R. C. Ward, R. D. Phillips, and C. H. Taylor.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-100058/AS. Price codes: AO7 in paper copy, AO1 in microfiche. Report No. EPA/600/3-89/037. March 1989. 150p, 58 fig, 25 tab, 20 ref, 2 append. EPA Cooperative Agreement CR813997.

Descriptors: *Acid rain, *Data processing, *Monitoring, *Statistical analysis, *Water quality, *Water quality trends, Analysis of covariance, Distribution, Kendall tests, Monte Carlo method, Seasonal variation, Serial correlation, t-Test.

Information goals for a long-term water quality monitoring program, to measure the impacts due to acid precipitation, were developed using the Acid Precipitation Act of 1980 (PL 96-294, Title VII) as a basis. These broad information goals were refined to obtain statistical hypotheses for which statistical tests could be employed as part of a data analysis plan. Seven statistical tests were identified as capable of providing the desired information regarding trends in individual systems--analysis of covariance (ANOCOV); modified t-test; Kendall-tau following removal of seasonal means; seasonal Kendall (SK); seasonal Kendall with serial correlation correction; ANOCOV on ranks; and modified 't' on ranks. The tests were evaluated under various conditions (i.e., distribution shape, seasonality and serial correlation) in order to determine how well they might perform as part of a data analysis plan. A Monte Carlo simulation approach was used to evaluate the tests. For annual sampling, the Kendall-tau (also known as the Mann-Kendall) test is recommended. For seasonal sampling, the Seasonal Kendall or analysis of covariance (ANOCOV) on ranks tests are recommended. (Author's abstract)
W91-03584

SEDIMENT QUALITY VALUES REFINEMENT; VOLUME 1 - DATA APPENDICES, 1988 UPDATE AND EVALUATION OF PUGET SOUND AET.
PTI Environmental Services, Bellevue, WA.
For primary bibliographic entry see Field 5A.
W91-03599

CASE STUDY EVALUATION OF SATELLITE-DERIVED RAINFALL ESTIMATES AND THEIR APPLICATION TO NUMERICAL MODEL PRECIPITATION FORECAST VERIFICATION.
National Weather Service Forecast Office, Milwaukee, WI.
For primary bibliographic entry see Field 2B.
W91-03600

BOREHOLE GEOPHYSICS APPLIED TO GROUND-WATER INVESTIGATIONS.
For primary bibliographic entry see Field 2F.
W91-03653

PROCEEDINGS OF THE SIXTH CORPS CHEMISTS MEETING, 16-17 MAY 1989.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5A.
W91-03659

CONDITIONABILITY, FILTERABILITY, SETTLEABILITY AND SOLIDS CONTENT OF SLUDGES 1984 (A COMPENDIUM OF METHODS AND TESTS): METHODS FOR THE EXAMINATION OF WATERS AND ASSOCIATED MATERIALS.
For primary bibliographic entry see Field 5D.
W91-03662

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY.
Geological Survey, Charleston, WV. Water Resources Div.
For primary bibliographic entry see Field 2E.
W91-03663

SIGNIFICANCE OF GIS AND REMOTE SENSING TECHNOLOGY IN GREAT LAKES MONITORING AND RESOURCE MANAGEMENT.
Wisconsin Univ.-Madison. Environmental Remote Sensing Center.
J. R. Vande Castle, R. G. Lathrop, and T. M. Lillesand.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 155-161, 3 fig, 1 tab, 7 ref.

Descriptors: *Geographic information systems, *Great Lakes, *Lake management, *Remote sensing, *Water quality management, *Water resources data, *Water resources management, Flow rates, Landsat images, Mapping, Spatial distribution, Temperature gradient, Water pollution sources, Water quality.

Great Lakes monitoring and resource management strategies require input from increasingly diverse and complex data sources. Conventional information such as population statistics, land use records and field sampling data need to be merged with more contemporary sources of information. Timely management decisions require up-to-date information including point source, real-time temperature or flow rate data, to space-based image maps of wetlands, temperature patterns or water quality parameters. Remotely-sensed data provide information covering a wide range of spatial and temporal scales. Systems such as Landsat-TM and SPOT-HRV can provide information with a spatial resolution of 30 to 10 m respectively, while sys-

tems such as NOAA-AVHRR can provide near real-time information at a spatial resolution of 1.1 km on a daily basis, limited only by cloud cover. Future systems such as SeaWiFS on Landsat-6 will be able to provide real-time wide-field multispectral data in conjunction with the Enhanced Thematic Mapper. The Geographic Information System (GIS) concept provides the framework to organize these complex and unstandardized data into spatial information. A GIS allows information, whether it is map-based, point source, or image-based to be located in space and/or time as a layer of information within a common database. The database can be updated or queried at any point and used for specific tasks such as flow rate analysis, diffusion rates and residence times. These derived data can then be included as additional layers within the database to provide information for management decisions of Great Lakes resources. (See also W91-03672) (Author's abstract)
W91-03689

GEOPHYSICAL DETERMINATION OF LAKEBED SEDIMENT HYDRAULIC PROPERTIES.
Wisconsin Univ.-Milwaukee. Dept. of Geosciences.
C. J. Hero, and R. W. Taylor.
IN: The Great Lakes: Living with North America's Inland Waters. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 163-171, 6 fig, 24 ref.

Descriptors: *Geophysical methods, *Great Lakes, *Lake management, *Water quality management, *Water resources management, Aquitards, Conductance, Electrical properties, Geohydrology, Hydraulic conductivity, Hydraulic properties, Lake sediments, Resistivity, Surface-groundwater relations, Water resources data.

The use of geophysical techniques to characterize hydrogeologic systems is of great interest to investigators who study systems that cover large areas, such as the determination of the interactions between the Great Lakes and the adjacent aquifers. These interactions are strongly dependent on the hydraulic properties of the lakebed sediments. Direct measurement of the hydraulic properties of the lakebed sediments of large lakes is costly, when even possible, thus the use of geophysical techniques is necessary. A number of geoelectrical methods have been proposed or used for the characterization of the hydrogeologic properties of aquifers, but the lakebed sediments are aquitards. These generally contain at least some clay, which limits or eliminates the usefulness of some of those methods, particularly the use of formation factor. Consequently, the longitudinal conductance method has been successfully utilized to provide hydrogeologic information essential for the determination of water fluxes between aquifers and lakes. The success of the longitudinal conductance technique does not preclude the existence of even more effective methods. Hydraulic conductivity and electrical resistivity show similar relationships to the percent clay in the sediment, thus direct application of electrical resistivity, through use of iterative inversion, shows promise for the future. (See also W91-03672) (Author's abstract)
W91-03690

RESULTS OF FIFTEEN YEARS OF CONTINUOUS MONITORING OF WATER QUALITY IN THE RUHR RIVER HEAVILY AFFECTED BY RESIDUAL POINT AND NONPOINT POLLUTION.
Ruhrverband, Essen (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W91-03733

ESTIMATION OF DIFFUSE INPUTS TO A COASTAL SEA: SOLUTION TO AN INVERSE MODELLING PROBLEM.
Institut Rudjer Boskovic, Zagreb (Yugoslavia).
For primary bibliographic entry see Field 2L.
W91-03817

DETECTION OF INITIAL EFFECTS OF POLLUTION ON MARINE BENTHOS: AN EXAMPLE FROM THE EKOFISK AND ELDFISK OILFIELDS, NORTH SEA.
Oslo Univ. (Norway). Inst. of Marine Biology.
For primary bibliographic entry see Field 5C.
W91-03837

DAM SAFETY: AN EVALUATION OF SOME PROCEDURES FOR DESIGN FLOOD ESTIMATION.
Salford Univ. (England). Dept. of Civil Engineering.
I. D. Cluckie, and M. L. Pessoa.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 5, p 547-569, October 1990. 7 fig, 2 tab, 44 ref.

Descriptors: *Dam stability, *Design floods, *Hydraulic properties, *Probable maximum precipitation, *Rainfall intensity, *Storm water, *Streamflow forecasting, England, Probable maximum flood, Radar, Statistical analysis, Stocks Reservoir, Unit hydrographs.

A number of aspects can be related to the estimation of dam design floods. A new approach to this estimation of probable maximum precipitation (PMP) takes advantage of the spatial variability of precipitation using radar-derived distributed rainfall measurements. Procedures which utilize storm transposition and storm maximization are introduced and the unit hydrograph method is employed to estimate the probable maximum flood. These results are compared with those obtained by the application of both Wakeby and generalized extreme value (GEV) distributions, these statistical functions being fitted by the method of probability weighted moments (PWMs) and used for both at-site and regional analyses. In addition, a case study is presented in which the techniques were applied to the Stocks Reservoir in the northwest of England. The following conclusions were drawn from the study: (1) the Wakeby distribution is widely recognized as a probability distribution which can deal with samples originating from a wide variety of formative processes; (2) the use of PWMs removes much of the subjectivity (apart from the treatment of outliers) of techniques; (3) the Wakeby/PWM method requires a larger database to provide reasonable, unbiased estimation of parameters then the GEV/PWM method; (4) the Wakeby distribution is more sensitive to outliers and short record length sites and shows a tendency to produce higher estimates than the GEV distribution, particularly for return periods $>$ 500 years; (5) at-site estimation of a very extreme event, such as 10,000 year flood, using typically available record lengths is nothing more than a well-informed guess; (6) the results produced using the RADMAX procedures and employing the UK Flood Studies Report unit hydrograph method were comparable to those obtained with other techniques; and (7) radar calibration (presently performed in real time using a limited number of rain gages by the UK Meteorological Office) is a crucial element when considering the utilization of the radar data archive in such studies. (Hoskin-PTT)
W91-03845

SINGLE-DOPPLER OBSERVATIONS OF A WEST AFRICAN SQUALL LINE ON 27-28 MAY 1981 DURING COPT 81: KINEMATICS, THERMODYNAMICS AND WATER BUDGET.
Centre de Recherches en Physique de l'Environnement, Issy-les-Moulineaux (France).
F. Roux, and S. Ju.
Monthly Weather Review MWREAB, Vol. 118, No. 9, p 1826-1854, September 1990. 22 fig, 3 tab, 52 ref, 2 append.

Descriptors: *Atmospheric physics, *Ivory Coast, *Meteorology, *Precipitation, *Remote sensing, *Squalls, *Storms, Condensation, Evaporation, Hydrologic budget, Mathematical analysis, Mathematical models, Radar.

A large and intense West African squall line was observed during the night of 27/28 May 1981 at Korhogo (along the north of Ivory Coast) during the COPT 81 experiment. Unfortunately, as only single-Doppler radar data are available, it is not possible to obtain detailed information on the small scale structure of the leading convective region. Taking advantage of the apparent stationarity of the mesoscale features, a new processing method (referred to as ABCD) has been developed for a combined processing of 12 successive conical scans, allowing deduction of three-dimensional wind and reflectivity fields in a domain of 260 x 60 x 15 cubic km, with resolutions of 20 km in the horizontal and 500 m in the vertical. The deduced circulation displays classical characteristics of trailing stratiform parts of mesoscale convective systems, with a mesoscale updraft above 4 km, a mesoscale downdraft below, and a relative rear-to-front flow of moderate intensity in the midlevels; all these features are slightly more intense than on 22 and 23-24 June 1981. Because of the propagation of the squall line in a direction slightly different from that of the environmental winds, the velocity component parallel to the line is relatively important. Pressure and temperature fields retrieved from an improved analysis of the momentum equation and of the thermodynamic equation show a warming due to condensation in the mesoscale updraft, cooling due to evaporation below, hydrostatic low pressure in the midlevels and high pressure near the surface. The vertical component of vorticity is weak and correlated with the horizontal divergence, while there is an anticorrelation between the shearing deformation and the horizontal divergence. The cross-line component of vorticity is weak compared with the along-line component. The baroclinic generation due to the horizontal buoyancy gradient is the dominant term in the budget of the along-line component of vorticity. However, the influence of the three-dimensional effects through the shearing-tilting term are also important. The water budget provides values of the different components relatively similar to those obtained in previous studies, with, however, a larger condensation rate due to the more important upward motions. (Author's abstract)
W91-03851

WINTER SHORT-PULSE RADAR STUDIES ON THE TANANA RIVER, ALASKA.
Cold Regions Research and Engineering Lab., Hanover, NH.
A. J. Delaney, S. A. Arcone, and E. F. Chacho.
Arctic ATICAB, Vol. 43, No. 3, p 244-250, September 1990. 8 fig, 24 ref.

Descriptors: *Alaska, *Data acquisition, *Frost, *Frozen ground, *Radar, *Remote sensing, *River channels, *Tanana River, Aerial photography, Channels, Fairbanks, Ice thickness, River ice, Soil horizons, Subarctic zone, Surveys.

Subsurface profiles were obtained during airborne and surface short-pulse radar surveys along a winter roadway over the Tanana River, near Fairbanks, Alaska. The roadway crossed ice covered channels and intervening frozen channel bars. The airborne profiles were intended for ice thickness profiling but also revealed sporadic reflections from a deeper horizon beneath the bars. Later profiling from the surface recorded these deeper reflecting horizons in detail, and they were found to correspond with the base of seasonal frost, measured in drill holes. The sediments immediately beneath the frozen material were saturated and represented the top of a seasonally variable groundwater table confined and controlled by frost penetration. The profiles made from the surface also revealed reflections from the bottom of the ice and the channel bottom. However, no significant reflections were observed beneath the channel bottom; reflections from sloping horizons above and below the base of the frost in the bar may indicate alluvial bedding patterns in these deposits. Eleven holes were drilled along the roadway to determine ice thickness, water and frost depth, and the depths to the river ice alluvium contact. Wide angle reflection and refraction soundings were also made to determine electrical properties of materials and to verify depth interpretations from echo times. These observations indicate that the airborne technique provides an effective method of locating unfrozen channels and measuring the depth of frost penetration beneath the bars. The surface surveys revealed additional data on sedimentary structure. (Author's abstract)
W91-03868

USE OF FIELD-FLOW FRACTIONATION TO STUDY POLLUTANT-COLLOID INTERACTIONS.
Monash Univ., Clayton (Australia). Water Studies Centre.
For primary bibliographic entry see Field 5B.
W91-03879

CHARACTERIZATION AND ASSAY CONDITIONS FOR USE OF ACHE ACTIVITY FROM SEVERAL MARINE SPECIES IN POLLUTION MONITORING.
Institut Francais de Recherche pour l'Exploitation de la Mer, Nantes. Lab. Effets Biologiques des Nuisances.
For primary bibliographic entry see Field 5A.
W91-03885

DETERMINATION OF RADON IN WATER BY ARGON PURGING AND ALPHA COUNTING WITH A PROPORTIONAL COUNTER.
Ecole Polytechnique, Montreal (Quebec).
L. Zikovsky, and N. Roireau.
International Journal of Radiation Applications & Instrumentation. A, Appl. Radiation & Isotopes ARISEF, Vol. 41, No. 7, p 679-681, 1990. 2 fig, 1 tab, 11 ref.

Descriptors: *Analytical methods, *Analytical techniques, *Data acquisition, *Drinking water, *Pollutant identification, *Radon, *Water analysis, *Well water, Carcinogens, Detection limits, Domestic water, Municipal water, Public utility districts, Radioactivity, Toxicity, Water quality.

Radon (222Rn) is a naturally occurring inert gas which diffuses from geological strata into ground water. When well water is used for domestic purposes such as drinking and washing, the radon release constitutes a potential source of radioactivity in indoor air. It has been estimated that over a period of 70 years, between 2000 and 40,000 lung cancer fatalities have been caused by the inhalation of natural radon released from U. S. public water supplies. Due to the highly toxic nature of radon it is important to be able to measure small concentrations of radon in water in a relatively simple way. This report describes the development of a new method of radon determination in water by purging with argon and counting in a proportional counter. The detection limit associated with this new method was calculated to be 0.02 Bq/L. The detection limit could be further reduced by increasing the volume of the sample or the counting time. The separation method used in this technique is reasonably fast and the detector was insensitive to beta emitters such as 85Kr. The analytical technique developed for the detection of radon is relatively simple, fast, very sensitive, and interference-free. The gas handling equipment can be assembled quite easily in any laboratory. The only drawbacks of the method were the 'memory effect' and the waiting period between measurements. (Korn-PTT)
W91-03888

APPLICATION OF LANDSAT THEMATIC MAPPING TO GEOLOGY AND SALINITY IN THE MURRAY BASIN.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
R. Johnston, and J. Kamprad.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 363-366, 1990. 6 fig, 2 tab, 4 ref.

Descriptors: *Australia, *Data interpretation, *Flow discharge, *Geohydrology, *Landsat images, *Mapping, *Murray-Darling River Basin, *Remote sensing, *Saline groundwater, Aeolian deposits, Field tests, Seepage, Vegetation.

In hydrological and geological studies in the Murray Basin in southeastern Australia, composite images derived from Landsat Thematic Mapper (TM) digital data enable excellent delineation of both ancient and active groundwater discharge zones, including strong zoning within active salinas. Differentiation of aeolian deposits, including lunettes, is possible only where there are distinctive vegetation associations. Landsat TM images can also be used, in conjunction with field checking, to detect areas where saline seepage zones are developing. The uncorrected TM data can be used as a guide to the extent of salinization and the evaporite mineral assemblages present within the salinas, providing the ephemeral nature of these is taken into consideration. The technique is applicable over the entire Murray Basin, but caution must be exercised when comparing scenes from different areas, as color differences between scenes recorded on different dates may result during processing of the data. This emphasizes the need for field checking each scene, and comparising pixel data for apparently similar areas in different scenes. The investigation demonstrates that Landsat TM has the potential for significant application to salinity studies in this environment, however, more advanced processing techniques than those applied should be investigated. (Fish-PTT)
W91-03907

DEVICE FOR IN SITU DETERMINATION OF GEOCHEMICAL TRANSPORT PARAMETERS: 2. BIOCHEMICAL REACTIONS.
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
R. W. Gillham, R. C. Starr, and D. J. Miller.
Ground Water GRWAAP, Vol. 28, No. 6, p 858-862, November/December 1990. 3 fig, 12 ref. Ontario Ministry of the Environment and NSERC Operating Grant No. 6414.

Descriptors: *Geochemistry, *Groundwater pollution, *In situ tests, *Instrumentation, *Measuring instruments, *Path of pollutants, Aquifer testing, Biodegradation, Chemical reactions, Data acquisition, Denitrification, Field tests, Groundwater data, Groundwater quality, Water chemistry.

Chemical and biological reaction rates are required for estimating migration rates of many reactive contaminants in groundwater, and as input data for mathematical models. Reaction rates must be measured, and depend on environmental conditions that are often difficult to duplicate in the laboratory. In situ rate measurements minimize the difficulties of controlling environmental variables such as temperature, pH, Eh, dissolved oxygen, solution and solid phase composition, and bacterial population. An instrument has been developed which isolates a 1.9-liter portion of an aquifer for in situ biochemical rate measurement. The device has been used successfully to measure the rate of reactions involving inorganic and organic contaminants in sandy aquifers. Two applications of the device, measurement of denitrification rates and rates of biodegradation of benzene, were examined, and the results show good agreement with results from previous studies. The in situ microcosm (ISM) is simple in design and is reasonably easy to operate. The method has a major advantage over large-scale injection tests in that it requires much less time and much less equipment. Furthermore, the test zone is isolated from the natural advective and dispersive processes in the aquifer, and thus the results are more easily interpreted; this can be a disadvantage if one wishes to study interactions of the degradation, advective, and dispersive processes. Though some degree of physical disturbance will occur during installation of the ISM, the chemical integrity of the test zone should be preserved. This is a major advantage over most laboratory test procedures. (Author's abstract)
W91-03909

DETERMINATION OF SPECIFIC STORAGE BY MEASUREMENT OF AQUIFER COMPRESSION NEAR A PUMPING WELL.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2F.
W91-03911

EFFECT OF SENSOR ERROR ON INTERPRETATION OF LONG-TERM WATER-LEVEL DATA.
Geological Survey, Denver, CO.
D. O. Rosenberry.
Ground Water GRWAAP, Vol. 28, No. 6, p 927-936, November/December 1990. 7 fig, 4 tab, 12 ref.

Descriptors: *Error analysis, *Instrumentation, *Measuring instruments, *Sensors, *Water level fluctuations, *Water level recorders, *Water measurement, Data storage and retrieval, Digital computers, Electrical equipment, Errors, Groundwater level, Monitoring wells, Nebraska, New Hampshire, Potentiometers, Strain gages.

Submersible strain-gage pressure transducers and potentiometer-float systems were used to monitor water-level fluctuations in wells. Use of uncorrected data from six pressure transducers at a site in New Hampshire would have caused an incorrect interpretation of the vertical hydraulic-head distribution. Seven potentiometer-float systems at a site in Nebraska provided data that indicated a slight attenuation of water-level fluctuations, which likely caused some small fluctuations to go unobserved. Digital data loggers were used at both sites to scan the sensors and calculate hourly and daily average values of water levels in the wells. Check measurements using a chalked steel tape were made weekly at the New Hampshire site and monthly at the Nebraska site. Comparisons of recorded data with check measurements indicated values measured by pressure transducers over periods of weeks to months were irregularly larger or smaller than the check measurement. This error was attributed to a drift of the zero reference point of the sensor, and was unpredictable. Values obtained by potentiometer-float systems lagged the water-level change indicated by the check measurements. The lag was attributed to the sum of the mechanical friction of the moving parts of the monitoring system. This error was somewhat constant and predictable. The average absolute error of six submersible pressure transducers that were in operation for 15 months was 0.098 foot. The average absolute error of seven potentiometer-float systems that were operated for 17 months was 0.027 foot. (Author's abstract)
W91-03918

7C. Evaluation, Processing and Publication

POTENTIOMETRIC SURFACE OF THE MAGOTHY AQUIFER IN SOUTHERN MARYLAND DURING SEPTEMBER 1988.
Geological Survey, Towson, MD. Water Resources Div.
F. K. Mack, D. C. Andreasen, S. E. Curtin, and J. C. Wheeler.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4040, 1990. 1p, 1 fig.

Descriptors: *Coastal plains, *Confined aquifers, *Magothy Aquifer, *Maps, *Maryland, *Potentiometric level, Cone of depression, Groundwater level, Maryland Coastal Plain, Wells.

A map showing the potentiometric surface of the Magothy aquifer in southern Maryland during the fall of 1988 was prepared from water-level measurements in 83 observation wells. The potentiometric surface was highest near the northwest boundary and outcrop area of the aquifer in topographically high locations of Anne Arundel and Prince Georges Counties. The hydraulic gradient in the study area was generally southeastward or toward the centers of three cones of depression that have developed in response to pumping stresses. These cones formed around well fields in the Annapolis, Waldorf, and Chalk Point areas. The potentiometric surface of the Magothy aquifer was more than 40 ft below sea level in parts of the Waldorf and Chalk Point areas. (USGS)
W91-02962

GEOHYDROLOGY AND NUMERICAL MODEL ANALYSIS OF GROUND-WATER FLOW IN THE PULLMAN-MOSCOW AREA, WASHINGTON AND IDAHO.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-02970

TECHNIQUES FOR ESTIMATING FLOOD-PEAK DISCHARGES OF RURAL, UNREGULATED STREAMS IN OHIO.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 2E.
W91-02972

MAP OF MEAN ANNUAL RUNOFF FOR THE NORTHEASTERN, SOUTHEASTERN, AND MID-ATLANTIC UNITED STATES, WATER YEARS 1951-80.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-02973

SIMULATION OF GROUND-WATER FLOW IN THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER IN EASTERN ARKANSAS.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-02976

LARGE SPRINGS IN THE VALLEY AND RIDGE PROVINCE IN TENNESSEE.
Geological Survey, Nashville, TN. Water Resources Div.
E. F. Hollyday, and M. A. Smith.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4205, 1990. 9p, 2 fig, 1 tab, 5 ref.

Descriptors: *Aquifer systems, *Data collections, *Flow duration, *Groundwater resources, *Hydrologic data, *Springs, *Tennessee, *Valley and Ridge province, *Water resources data, Discharge measurement, Maps, Statistical analysis.

Approximately 2,700 miscellaneous discharge measurements for 171 large springs in 28 counties of East Tennessee, predominantly within the Valley and Ridge physiographic province, were analyzed statistically and results tabulated to summarize data useful to the Appalachian Valleys-Piedmont Regional Aquifer System Analysis study. The number of measurements at each spring ranged from 1 to 65. Information from each spring includes station numbers, latitude, longitude, spring name and where data are sufficient, an estimate of the mean discharge and the discharge exceeded by 75%, 50%, and 25% of the miscellaneous measurements. Data are referenced to locations on a 1:1,000,000-scale map. The highest mean spring discharge was 32.2 cu ft/sec (14,5000 gallons/min). (USGS)
W91-02979

STRUCTURE AND APPLICATION OF AN INTERFACE PROGRAM BETWEEN A GEOGRAPHIC-INFORMATION SYSTEM AND A GROUNDWATER FLOW MODEL.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-02980

QADATA USER'S MANUAL: AN INTERACTIVE COMPUTER PROGRAM FOR THE RETRIEVAL AND ANALYSIS OF THE RESULTS FROM THE EXTERNAL BLIND SAMPLE QUALITY-ASSURANCE PROJECT OF THE U.S. GEOLOGICAL SURVEY.
Geological Survey, Denver, CO. Water Resources Div.
K. J. Lucey.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-162, 1990. 53p, 2 fig, 3 tab, 13 ref.

Descriptors: *Computer programs, *Quality assurance, *Water analysis, Information retrieval, Quality control, Statistics.

The U.S. Geological Survey conducts an external blind sample quality assurance project for its National Water Quality Laboratory in Denver, Colorado, based on the analysis of reference water samples. Reference samples containing selected inorganic and nutrient constituents are disguised as environmental samples at the Survey's office in Ocala, Florida, and are sent periodically through other Survey offices to the laboratory. The results of this blind sample project indicate the quality of analytical data produced by the laboratory. This report provides instructions on the use of QADATA, an interactive, menu-driven program that allows users to retrieve the results of the blind sample quality-assurance project. The QADATA program, which is available on the U.S. Geological Survey's national computer network, accesses a blind sample data base that contains more than 50,000 determinations from the last five water years for approximately 40 constituents at various concentrations. The data can be retrieved from the database for any user-defined time period and for any or all available constituents. After the user defines the retrieval, the program prepares statistical tables, control charts, and precision plots and generates a report which can be transferred to the user's office through the computer network. A discussion of the interpretation of the program output is also included. This quality assurance information will permit users to document the quality of the analytical results received from the laboratory. The blind sample data is entered into the database within weeks after being produced by the laboratory and can be retrieved to meet the needs of specific projects or programs. (USGS)
W91-02981

DEVELOPMENT OF SYSTEMS.
Michigan State Univ., East Lansing. Inst. of Water Research.
J. F. Bartholic.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 15-22, 1 fig.

Descriptors: *Agriculture, *Geographic information systems, *Hydrologic models, *Information systems, *Nonpoint pollution sources, *Water pollution control, *Watershed management, Data processing, Decision making, Evaluation, Systematics, Technology transfer.

When studying a complex set of interactions (as in an agricultural watershed), some sort of organizing scheme is crucial to study human impacts and evaluate alternatives. A systems approach involves an effort to systematize the physical and biological system and the social process of using highly technical information as a basis for facilitating planning and management at the watershed and farm level. Further, the system should allow for predictions of impacts and potential improvements should a wide array of improved practices be implemented. The most important physical and biological processes occurring must be linked from a process standpoint, taking into account agronomic practices at the land surface, with emphasis on understanding the linkages between submodels within the total system. In the process of transferring this technical knowledge to a social system, the economic, motivational, institutional, time, and education requirements that must be impacted for changes to occur in the way individuals and farmers handle their portion of the larger landscape must be considered. Spatial information systems, with the capability of overlaying spatial information (soils, land use, etc.) and associated tabular data, are available. These generally are referred to as geographic information systems (GIS), useful in providing a structure for tieing together spatial information for models and predictions, and facilitating a general pathway for technology transfer, technical assistance, and feedback from the end-users. Once spatial information is in the system, the layers or the layers' attributes can be mathematically handled through process or statistical models. The overall elements of a total system leading to local implementation starts with process models, requiring systemization and regionalization. A strong, highly focused, systematic approach to integrate the process models is essential, including: operationalization; needs assessment and data needs; environmental/economic impacts; social adaptive process; decisions made and investments; and feedback. (See also W91-02985) (Fish-PTT)
W91-02989

SURFACE WATER QUALITY MODELS.
For primary bibliographic entry see Field 5G.
W91-02993

ROLE OF ENVIRONMENTAL MODELING IN THE DECISION-MAKING PROCESS.
For primary bibliographic entry see Field 5G.
W91-02996

EPA'S CEEPES PROJECT: DESCRIPTION AND DATA NEEDS.
For primary bibliographic entry see Field 5G.
W91-02997

SOIL CONSERVATION SERVICE CLIMATIC DATA ACCESS FACILITY.
Soil Conservation Service, Washington, DC. Resources Inventory Div.
B. A. Shafer.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 61-62.

Descriptors: *Agriculture, *Climatic data, *Data storage and retrieval, *Hydrologic data collections, *Nonpoint pollution sources, *Resources management, *Water pollution control, Hydrologic cycle, Management planning, Soil conservation.

Reliable, readily accessible climatic data are essential for planning and implementing resource management systems. Climate parameters are the driving forces in the processes associated with the hydrologic cycle, soil erosion, and plant growth. They are thus key to any concerted effort aimed at addressing water quality and quantity issues in the agricultural environment. An interdisciplinary task force was commissioned to study alternative means to correct the deficiency of the Soil Conservation Service to acquire, manage, interpret, and effectively use climate data in its operations. The recommendation of that task force was to create a Climate Data Access Facility (CDAF) to serve as the primary focal point for intra-agency climate data access. It is not the intent of CDAF to duplicate databases and services that can more efficiently be obtained elsewhere; only those data that are required to support operational programs or that are frequently used will be kept online for interactive retrieval. The CDAF cannot fulfill its intended purpose without a national network of support personnel. A small dedicated staff will operate the CDAF, augmented by climatic liaisons at technical centers. (See also W91-02985) (Fish-PTT)
W91-02998

SOCIO-ECONOMIC DATA RELATING TO THE WATER QUALITY INITIATIVE.
Economic Research Service, Washington, DC. Resources and Technology Div.
For primary bibliographic entry see Field 5G.
W91-02999

DEVELOPMENT OF THE NATIONAL RESOURCES INVENTORY.
Soil Conservation Service, Washington, DC.
J. J. Goebel, and B. A. Shafer.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 69-71, 3 ref.

Descriptors: *Agriculture, *Data collections, *Natural resources, *Nonpoint pollution sources, *Resources management, *Water pollution control, *Water resources data, Conservation, Environmental policy, Governmental interrelations, Land use, Water sampling.

The U.S. Department of Agriculture's Soil Conservation Service (SCS) has conducted periodic inventories of the nation's soil, water, and related resources for over 50 years. The National Resources Inventory (NRI) produces estimates of non-federal land cover and use, rates of sheet, rill, and wind erosion, conservation treatment needs, the extent of highly erodible cropland, and many other resource characteristics and related soil properties, based upon data collected at scientifically-selected random sample sites located in all U.S. counties. The 1987 NRI updated selected 1982 NRI data items for a subsample of 1982 NRI sample sites; it was specifically designed to detect significant 5-year trends in the condition of the nation's natural resources. Sufficient data were collected from a statistically-selected sample to allow for analysis of resource conditions at the state level. For the 1987 NRI, data were collected for nearly 1 million sample sites. The NRI is the federal government's principal source of information on the status, condition, and trend of soil, water, and related resources on the nation's non-federal lands. NRI data serve a wide range of purposes, among them: monitoring trends, helping formulate state and national policy, appraising progress of conservation programs, providing information to agency management, and aiding in research and modeling efforts. The 1987 NRI data are being made available in many forms: a USDA statistical bulletin, a computerized system available at Iowa State University, and through SCS state offices. (See also W91-02985) (Fish-PTT)
W91-03000

SOLID-EARTH SCIENCE DATA BASES.
Geological Survey, Reston, VA.
J. C. Matti, and J. M. McNeal.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 73-84.

Descriptors: *Agricultural chemicals, *Databases, *Geologic mapping, *Mapping, *Nonpoint pollution sources, *Path of pollutants, *Water pollution control, Baseline studies, Geochemistry, Geophysical methods.

A variety of solid-earth map-based databases are available to facilitate research and planning in the agricultural arena. Solid-earth maps provide a framework for a host of different topical investigations, such as determination of non-point sources of agricultural chemicals. The various solid-earth map types can be grouped into three major categories: geologic maps, geochemical maps, and geophysical maps. A geologic map contains both descriptive information (physical properties, three-dimensional geometry, relative age relations, and origin of material and structures) and an interpretive model. Geochemical maps provide statistically reliable geochemical baseline against which potentially unusual samples may be judged; provide a basis for judging future geochemical changes; and provide a basis for estimating geochemical processes. Geophysical maps are integrated with other maps in addressing environmentally oriented problems, using: ground-penetrating radar, remote sensing, electromagnetic induction, complex resistivity, well-logging, and magnetic, seismic, radiometric, gravity, and borehole techniques. When used in combination, the mapping techniques provide a powerful analytical package for portraying the surface and subsurface geologic framework of an area or region. (See also W91-02985) (Fish-PTT)
W91-03001

ANALYZING NATIONAL FARM CONSERVATION POLICY IN A NATIONAL GIS.
Center for Resource Innovations, Washington, DC.
For primary bibliographic entry see Field 6B.
W91-03003

GEOLOGIC MAPPING FOR PROTECTION OF GROUNDWATER RESOURCES.
D. P. McKenna.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 99-100, 4 ref.

Descriptors: *Agricultural chemicals, *Geologic mapping, *Groundwater pollution, *Groundwater resources, *Nonpoint pollution sources, *Path of pollutants, *Water pollution control, Aquifer systems, Geohydrology, Geologic control, Groundwater movement, Mapping, Soil properties.

Accurate prediction of the vulnerability of groundwater resources to contamination from agricultural chemicals is one of the most important environmental issues facing farmers, water users, and state and federal agencies. Aquifer vulnerability to agricultural chemical contamination is a function of soil properties and hydrogeologic conditions. While it is recognized that the character of earth materials influences the fate of contaminants, geology (the study of the earth) is not viewed as playing an important role in addressing the issue of agricultural chemical contamination of groundwater (or surface water) resources. However, an approach to three-dimensional geologic mapping has been developed that is material-oriented and designed to produce geologic information that can be directly interpreted for specific uses. The first product of this approach is a stack-unit map which provides information on geologic materials to a given depth over specified areas. Once the basic geologic framework has been established and the materials characterized, the presence and distribution of aquifers can be predicted. Application of basic hydrologic concepts on water movement and contaminant transport allows for predictions of the rate and direction of groundwater flow and the vulnerability of underlying aquifers to contamination. An accelerated program should be developed to assess the geohydrology in the most vulnerable areas is necessary for state and federal agencies to accurately target educational and monitoring programs, and potentially to implement pesticide use regulations. (See also W91-02985) (Fish-PTT)
W91-03005

STATE DATA BASE CAPABILITIES, WISCONSIN.
Wisconsin Univ.-Madison. Dept. of Agricultural Engineering.
G. D. Bubenzer.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 101-103.

Descriptors: *Databases, *Governmental interrelations, *Groundwater pollution, *Nonpoint pollution sources, *Water pollution control, *Water resources management, *Wisconsin, Data collections, Data quality control, Data storage and retrieval, State jurisdiction, Water quality.

The Wisconsin Comprehensive Ground Water Protection Act was signed into law in May, 1984. The act expanded Wisconsin's legal, organizational, and financial capacity for controlling groundwater pollution. The groundwater program evolving as a result of this act has five major components: Standards, Regulations, Monitoring and Data Management, Research, and Coordination. In order to help insure coordination between the various agencies, the Ground Water Coordinating Council was created to advise and assist state agencies in the coordination of non-regulatory programs and to exchange information related to groundwater. Databases related to water quality are currently available within several state and local database systems. Unfortunately, until very recently little was done to coordinate the collection of the data and development of the data bases. Evaluation of the quality of the data in existing data banks is needed in order to insure that interpretations based on the data are factual. Wisconsin agencies are moving toward a uniform system of reporting water quality data. This system should encourage uniform documentation of sampling procedures and environmental conditions that may be contributing to groundwater contamination, and facilitate transfer of data between databases and increase the utilization of data by researchers and regulators. The greatest need is to provide assurance that data entered into the databases have been collected with sufficient quality control to insure reliability. (See also W91-02985) (Fish-PTT)
W91-03006

STATE OF MINNESOTA DATA BASE CAPABILITIES.
Minnesota Dept. of Agriculture, St. Paul.
J. W. Hines.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 105-107.

Descriptors: *Agricultural chemicals, *Databases, *Geographic information systems, *Mapping, *Minnesota, *Nonpoint pollution sources, *Water pollution control, Computer programs, Fertilizers, Groundwater management, Monitoring, Pesticides, Water quality, Water resources management.

There are two major database systems in Minnesota, both of which are housed at the Minnesota State Planning Agency's Land Management Information Center (LMIC). This organization is charged with the compilation of data on natural resources of the state. Both groundwater quality and quantity as well as geological and geographical information are included in the systems. The first database contains data and information compiled in raster format for use with the state geographic information system (GIS). Each data point represents a 40-acre grid cell and corresponds to a color number for mapping purposes. Second generation databases will be digitized from 7.5 minute quadrant and compiled on a 100-meter grid, solving some resolution problems. The second of the major sources of data available in Minnesota is being compiled as part of the Ground Water Data Clearinghouse. This database is still in the developmental stage and may appear quite different when it is complete. The database is menu-driven for user-friendly interfacing. The CWI database will contain substantial information, including long-term (four years, to date) water quality monitoring data on pesticide and nitrate-nitrogen concentrations from the Minnesota Department of Agriculture's monitoring programs. Each well in the database may have data on more than 31 agricultural chemicals. The number of wells and number of analytes is constantly expanding, but will be updated periodically for database completeness. (See also W91-02985) (Fish-PTT)
W91-03007

STATE DATABASE CAPABILITIES: THE MICHIGAN EXPERIENCE.
Michigan State Univ., East Lansing. Dept. of Resource Development.
B. E. Vieux.
IN: Information Exchange on Models and Data Needs Relating to the Impact of Agricultural Practices on Water Quality: Workshop Proceedings. U.S. Geological Survey, Reston, Virginia. 1990. p 109-111.

Descriptors: *Databases, *Mapping, *Michigan, *Nonpoint pollution sources, *Water pollution control, *Water resources management, Computer models, Data collections, Geographic information systems, Remote sensing, Soil surveys, State jurisdiction.

A considerable amount of data has been gathered concerning the location of land and water resources in the state of Michigan. By capturing original data sets, the information content is maintained regardless of end uses which are many and varied. For example, modern soil surveys are digitized in a vector/polygon format ensuring that the original detail of the mapping is preserved. Interpretations of these maps are left to the user and not stored as part of the database nor is any grid cell or raster format used in the database which may degrade the resolution and information content of the data. The types of maps that are available to a varying degree of completion for the 83 counties in

Michigan under the categories of the Michigan Resource Information System (MIRIS) map sets and the Great Lakes Information System map sets. Efforts to provide access to the MIRIS database are under way through the Center for Remote Sensing, Michigan State University. Potential applications and uses of digital databases should offer insight into gaps in database information. Interpretations of reasonable values must be supplied to the model or the data must be collected and added to the database. Model and geographic information system integration can guide database development and quality-assurance/quality-control. Agricultural impacts on land and water resources can be assessed and minimized using this technology only through cooperation of the data gatherers at state and federal agencies, and researchers both in government and at universities. (See also W91-02985) (Fish-PTT)
W91-03008

NATIONAL WATER INFORMATION SYSTEM USER'S MANUAL. VOLUME 2, CHAPTER 4. GROUND-WATER SITE INVENTORY SYSTEM.
Available from the U.S. Geological Survey, Books and Open-File Reports Section, Federal Center, Bldg. 810, Box 25425, Denver, Colorado 80225. USGS Open-File Report No. 89-587. 227 p, 16 fig.

Descriptors: *Data storage and retrieval, *Databases, *Groundwater data, *Hydrologic data collections, *Manuals, *National Water Information System, Computers, Information exchange, Networks.

The Groundwater Site Inventory (GWSI) System is a groundwater data storage and retrieval system that is part of the National Water Information System (NWIS) developed by the US Geological Survey (USGS). The NWIS is a distributed water database in which data can be processed over a network of minicomputers at the USGS offices throughout the United States. This system comprises the Automated Data Processing System, the GWSI System, the Quality of Water System, and the Water-Use Data System. The GWSI provides for entering new sites, updating existing sites within the local database, (WATSTORE), which is the national data base. In addition, the GWSI System provides for retrieving and displaying groundwater and surface water data stored in the local database. Finally, the GWSI System provides for routine maintenance of the local and national data files. This manual contains instructions for users of the System and discusses the general operating procedures for the programs found within the main menu. (Author's abstract)
W91-03013

GEOCHEMICAL COMPUTER CODES: A REVIEW, FINAL REPORT.
K. Andersson.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-617981. Price codes: A06 in paper copy, A01 in microfiche. Report No. NP-87/86, August 1987. 109 p, 30 fig, 9 tab, 44 ref, append.

Descriptors: *Computer programs, *Data interpretation, *Data processing, *Geochemistry, Chemical interactions, Chemical speciation, Comparison studies, Equilibrium.

Since the 1960's a large number of geochemical computer codes for various applications have been published. A large number of these codes address groundwater, lake water and sea water. Most of the computer codes treat equilibrium conditions, although some codes are available with a kinetic capability. Some of the codes solve equilibrium and transport equations simultaneously and require a large computer capacity. Three code intercomparisons were found in the literature which indicate that there are many geochemical codes available for geochemical calculations. These intercomparisons show that: speciation for major components works well for most codes; speciation of minor components give larger deviations; the databases are the main sources of discrepancy; many of the codes have poor documentation and it is difficult for a user to set up a problem; many problem formulations may cause codes to fail to converge. 'Good' starting estimates may be necessary for convergence; the choice of activity coefficient calculation method may be important to the result at higher ionic strengths (above 0.5); some codes cannot treat all the problems set up in the intercomparisons (eg, adsorption and precipitation under certain conditions); in codes where adsorption is included, a large number of different algorithms are used. These have different advantages and disadvantages, but it is difficult to set up an algorithm that covers both variations in pH and concentration, and where the input parameters are easily available; and, in the complicated test case of fly ash leaching, performed within the EPRI intercomparison, large differences between experimental and calculated data as well as between data calculated by the two codes compared were observed. This is attributed to mathematical differences in the codes, database differences and to the fact that equilibrium may not have been attained in the experiment. (Lantz-PTT)
W91-03027

AQUIFER PROPERTIES DATABASE.
Illinois State Water Survey Div., Champaign.
K. J. Hlinka, S. J. Cravens, and R. C. Kohlhase.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 4A-5--4A-11, 3 fig, 1 tab, 4 ref.

Descriptors: *Aquifer characteristics, *Aquifers, *Databases, *Groundwater data, *Hydrologic data collections, *Illinois, *Water management, *Water resources data, Data storage and retrieval, Geohydrology, Information exchange.

The Groundwater Section of the Illinois State Water Survey (ISWS) has collected information on more than 4,500 well and aquifer production tests conducted throughout Illinois since the early 1920's. This information has been compiled into a useable, computerized database that tabulates more than 22 aquifer property and well informational fields. The database is continually updated by the ISWS and used by ISWS staff as well as consultants, engineers, geologists, and hydrologists in research, design, and planning projects. This information has practical significance for site-specific and regional planning applications. The availability of extensive, statewide aquifer property data within a single database promises to be a powerful tool for future investigations. However, it is still important to maintain the original field data from which the aquifer properties database was created and to use it in combination with this computerized information. (See also W91-03032) (Lantz-PTT)
W91-03046

HYDROLOGIC DATA BASE MODEL.
South Florida Water Management District, West Palm Beach.
B. R. Turcotte.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 4A-13--4A-22, 5 fig, 8 ref.

Descriptors: *Data storage and retrieval, *Databases, *Florida, *Hydrologic data, *Model studies, *Network design, *Water management, *Water resources data, Data interpretation, Hydrologic data collections, South Florida Water Management District.

The South Florida Water Management District operates and maintains a corporate hydrologic database, DBHYDRO, for the region within and near the district boundaries which ranges from the Orlando area to beyond Key West. DBHYDRO allows easy access to over 35,000 station years of data collected at over 6500 stations in and around the SFWMD. DBHYDRO has been in production since late 1985. Subsequently, objectives have changed and limitations in the original database logic have been recognized. Changes in the South Florida Water Management District's (SFWMD) computer hardware and operating system have required the reimplimentation of the SFWMD's hydrologic database. The SFWMD's new hydrologic database design starts with a data model which incorporates concepts of entity-relationship (E-R) modeling. E-R modeling is a tool used to organize and represent relationships by making use of consistent graphic notation. Describing relationships in their most fundamental form affords maximum generality for database design, and is hardware and software independent. (See also W91-03032) (Lantz-PTT)
W91-03047

LESSONS LEARNED WHILE DEVELOPING PICS DATABASE.
Illinois State Water Survey Div., Champaign.
J. R. Kirk, and D. M. Woller.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 4A-23--4A-29, 5 fig.

Descriptors: *Data storage and retrieval, *Databases, *Hydrologic data, *Illinois, *Public-Industrial-Commercial Survey dat, *Water management, *Water resources data, *Water use, Computer programs, Water resources development.

The organization of capabilities of the Public-Industrial-Commercial Survey (PICS) database of the Illinois Water Inventory Program (IWIP), and its interaction with the geographic information system (GIS), is presented. The IWIP was initiated in 1978 as an effort to bring together the diverse collection of water resource information in the State of Illinois and to document the states water use. The PICS database, developed within this program, is a site specific database that contains information about high-capacity wells or intake points. It utilizes a standard query language relational database management system to store and retrieve information. A number of apparent lessons were learned with the development of the PICS database. One of the most important is the need for a unique identifier for use with each data record. When possible, cross-referenced names, other identification numbers, and historical information should be included in the database so that other data can be utilized in combination with this information. The simplest way to accomplish this is to let the computer generate a unique ID code, either random or sequential, and never reuse this ID. Verification of data should be of major concern in developing a database. In addition, several other observations were made: (1) extra effort must be taken in designing a database to meet management objectives and goals; (2) care should be taken in terms of data decentralization; (3) avoid the use of special extensions in computer program languages in order to make applications transferable; and (4) GIS system compatible coordinates should be used for local reference. (See also W91-03032) (Lantz-PTT)
W91-03048

SITE SELECTION MODEL FOR ACQUISITION OF WATER RESOURCE LANDS: A GIS APPLICATION.
Southwest Florida Water Management District, Brooksville.
R. Christianson.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 10A-5--10A-18, 4 fig, 1 tab, 4 ref.

Descriptors: *Data interpretation, *Florida, *Geographic information systems, *Model studies, *Site selection, *Water resources development, *Water resources management, Flood plains, Information exchange, Maps, Potable water, Vegetation.

A computer-based Geographic Information System application has been designed to identify lands within the 10,000 sq mile Southwest Florida Water Management District most critical for acquisition for the protection of water resources. This model combines over 30 layers (maps) of information through techniques such as overlaying, buffering, and the development of map themes through solving analytic equations. These layers include parameters such as flood plains, land cover, location of potable water supply sources, population, and topography. Model results are expressed in maps targeting lands for various combi-

nations of flood protection, water supply protection, natural systems protection, and management and acquisition concerns. (See also W91-03032) (Author's abstract)
W91-03067

IMPLEMENTATION OF AN OPERATIONAL GEOGRAPHIC INFORMATION SYSTEM FOR MULTIPURPOSE WATERSHED MANAGEMENT.
Salem State Coll., MA. Digital Geography Lab.
W. L. Hamilton, K. Barnes, B. Bishop, and W. Lingsch.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 10A-19--10A-24, 1 ref.

Descriptors: *Geographic information systems, *Information systems, *Quabbin Reservoir, *Water resources management, Boston, Information exchange, Water management, Water resources development, Water supply.

Management operations on the Quabbin Watershed in Massachusetts are being supported with a Geographic Information System (GIS). The Quabbin Reservoir is managed by the Metropolitan District Commission (MDC) to supply the Boston Metropolitan area with water. MDC's management goals for Quabbin are: (1) to increase water yields and maintain water quality; and (2) to protect and enhance its natural and cultural values. All activities within the watershed must serve these goals, and the Quabbin resource managers are using GIS as a tool to help ensure compliance. Quabbin's GIS is setup according to the expressed needs of the managers, so as to compliment and augment their current operations. Moreover, GIS is project specific rather than generic. Its implementation is incremental and integrated, for individual GIS are developed for specific management units. These are subsequently linked with the inclusion of additional contiguous management units. This reduces the time required for the system to become operational. Furthermore, managers have greater flexibility in realizing the GIS potentials and limitations, including hardware limitations. (See also W91-03032) (Author's abstract)
W91-03068

INFORMATION: THE MOST UN-MANAGED RESOURCE IN WATER MANAGEMENT.
QUAD Data Corp., Tallahassee, FL.
D. W. McEwen.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 10B-3--10B-12.

Descriptors: *Florida, *Information management, *Information systems, *Water resources management, Data storage and retrieval, Databases, Water resources data.

Florida is committed to managing growth and preserving a certain quality of life for future and present generations. As the population and the economy grows, problems will escalate and become more critical. Effective information management will become increasingly important. Current management of information is somewhat haphazard compared to management of other vital resources. Data elements are frequently not defined or structured consistently between organizational units. While adequate for first time use of data, subsequent use is generally too cumbersome and labor intensive. Databases are rarely documented. The lack of a cohesive organizational plan and a lack of leadership contribute to this situation. It appears that the most beneficial action for the State to take in the immediate future is as follows: (1) Create a state-wide information locator system which would contain information about the data sets and contact people; (2) Require every agency to create and maintain a comprehensive data dictionary; (3) Coordinate the creation of state-wide data element definitions and encourage every agency to become compatible; (4) Establish data transfer procedures and the telecommunications infrastructure to make data transfer easy and practical; (5) Develop a uniform methodology for calculating reimbursement costs for information retrieval and preparation services; (6) For the foreseeable future, have users simply locate the information and retrieve what they need from the source; (7) Encourage the private sector to provide value added services regarding the timely retrieval, reformatting, and conversion of selected data for the end user; and (8) Address the reluctance of state agencies and employees to use value added services. (See also W91-03032) (Lantz-PTT)
W91-03074

STRINGFELLOW HAZARDOUS WASTE SITE: COMPUTERIZED DATA MANAGEMENT.
CH2M Hill, Santa Ana, CA.
S. K. Gupta, U. P. Singh, and R. Gupta.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 13A-1--13A-10, 10 fig, 5 ref. EPA Contract No. 68-01-7251.

Descriptors: *Cleanup, *Computer programs, *Data interpretation, *Hazardous waste disposal, *Waste disposal, *Waste management, *Water pollution treatment, California, Data storage and retrieval, Databases, Economic aspects, Geohydrology, Hazardous wastes, Model studies, Riverside.

The Stringfellow Hazardous Waste site, a former (1956-1972) 17-acre Class I industrial liquid waste disposal facility, is approximately 5 miles northwest of Riverside, California. At this site, millions of gallons of organic and inorganic liquid industrial waste were deposited in unlined ponds. These wastes have contaminated soils and groundwater under the site, and the contaminant plume has migrated toward the Glen Avon Community. EPA has marked this as California's topmost priority hazardous waste site for cleanup under the federal Superfund program. This study presents: (1) the need for computerized data processing; (2) physiographic features of the site; (3) partial geohydrological information of the site; (4) processing of the contaminant distribution data; and (5) development of a preliminary three dimensional finite element conceptual model of the site. The database at a given hazardous waste site is one of the most important components of the project. At a fraction of the cost of field and laboratory investigations, computerized data processing using geographic information systems and custom made software, as initiated at the Stringfellow site, maximizes efficient interpretation, use, and storage of the database. It also facilitates the generation of maps in required scale, the production of composite maps of different coverage (relevant information), and the generation of input files for analysis. (See also W91-03032) (Lantz-PTT)
W91-03080

MODELING THE HYDROLOGIC IMPACTS OF PHOSPHATE MINING AND RECLAMATION IN CENTRAL FLORIDA.
Bromwell and Carrier, Inc., Lakeland, FL.
For primary bibliographic entry see Field 4C.
W91-03082

PLANNING TOOL FOR WATER CONSERVATION.
Brown and Caldwell, Tampa, FL.
For primary bibliographic entry see Field 6A.
W91-03091

STOCHASTIC SIMULATION OF GULLY NETWORKS ON ERODED LAND.
Tokyo Univ. (Japan). Faculty of Agriculture.
For primary bibliographic entry see Field 2J.
W91-03133

SEDIMENT YIELD MODELING OF ROADWAYS.
New Mexico State Univ., Las Cruces. Dept. of Civil, Agricultural and Geological Engineering.
For primary bibliographic entry see Field 2J.
W91-03134

ADJUSTING THE UNIVERSAL SOIL LOSS EQUATION FOR USE IN WESTERN EUROPE.
Faculte des Sciences Agronomiques de l'Etat, Gembloux (Belgium).
For primary bibliographic entry see Field 2J.
W91-03136

PHYSICAL COMPONENTS OF THE EPIC MODEL.
Agricultural Research Service, Temple, TX. Grassland, Soil and Water Research Lab.
For primary bibliographic entry see Field 2J.
W91-03138

EFFECTIVENESS OF EI30 AS AN EROSIVITY INDEX IN HAWAII.
Hawaii Univ., Honolulu. Dept. of Agronomy and Soil Sciences.
For primary bibliographic entry see Field 2J.
W91-03146

MODIFYING THE UNIVERSAL SOIL LOSS EQUATION FOR FOREST LAND.
Forest Service, Atlanta, GA.
For primary bibliographic entry see Field 2J.
W91-03156

RESEARCH ON THE UNIVERSAL SOIL LOSS EQUATION IN INDIA.
Central Soil and Water Conservation Research and Training Inst., Dehra Dun (India).
For primary bibliographic entry see Field 2J.
W91-03157

APPLICABILITY OF THE UNIVERSAL SOIL LOSS EQUATION (USLE) AND MODIFIED USLE IN HAWAII.
Agricultural Research Service, Boise, ID. Northwest Watershed Research Center.
For primary bibliographic entry see Field 2J.
W91-03158

EXPERIMENTALLY DERIVED MODIFICATION OF THE USLE.
Agricultural Research Service, Oxford, MS. Sedimentation Lab.
For primary bibliographic entry see Field 2J.
W91-03159

NEW MATHEMATICAL MODEL OF SOIL EROSION AND DEPOSITION PROCESSES WITH APPLICATIONS TO FIELD DATA.
Griffith Univ., Nathan (Australia).
For primary bibliographic entry see Field 2J.
W91-03162

EXPERIMENTAL MODEL OF EVALUATING SOIL EROSION ON A SINGLE-RAINSTORM BASIS.
Istituto Sperimentale per lo Studio e la Difesa del Suolo, Florence (Italy).
For primary bibliographic entry see Field 2J.
W91-03163

HYDROGEOLOGICAL PARAMETER ESTIMATION TECHNIQUES: LOCAL TEST, MODEL FITTING, STOCHASTIC METHODS, AND THE USE OF TRACERS.
Paris-4 Univ. (France).
For primary bibliographic entry see Field 2F.
W91-03183

STOCHASTIC SPATIAL PREDICTION OF HYDROGEOLOGIC PARAMETERS: ROLE OF CROSS-VALIDATION IN KRIGINGS.
National Geophysical Research Inst., Hyderabad (India).
S. Ahmed, and C. P. Gupta.
IN: Appropriate Methodologies for Development and Management of Groundwater Resources in Developing Countries. Volume III. Proceedings of an International Workshop held February 23-March 4, 1989. A. A. Balkema, Rotterdam. 1989. p 77-90, 3 fig, 14 ref.

Descriptors: *Developing countries, *Hydrologic models, *Kriging, *Model studies, *Parametric hydrology, *Water resources development, Analytical methods, Geohydrology, Groundwater management, Hydrologic data, Stochastic hydrology, Stochastic models, Water resources management.

Stochastic treatment of spatial processes has been realized mainly with the theory of regionalized variables and it is now being used quite extensively in many fields of earth science as well as other sciences. The main handicap in applying kriging to hydrogeological problems is the scarcity and sparsity of observed data. However, a few modifications and additions to the existing techniques permit utilization of hydrogeological data successfully in spatial prediction of aquifer parameters. The use of several properties of a system together in estimation has proven to be useful both physically and mathematically. Cross-validation is most useful when there are less data, as in the case of hydrogeologic parameters. It is found that cross-validation checks ambiguous structural models, decides the appropriate range, and selects the suitable combination of the additional information. Cross-validation may be employed in deciding the best external drift function when there are more than two types of additional information. Even in the method of kriging with an external drift, a conditional variogram which is a combination of several variograms and cross-variograms should be used, but practical examples show that a modified variogram of the main variable through cross-validation can be easily utilized for estimation. An important role of cross-validation is to sort the unreliable data out which are called outliers in geostatistical language. (See also W91-03178) (Author's abstract)
W91-03184

GEOHYDROLOGICAL DATA BASE FOR WATER MANAGEMENT.
Jawaharlal Nehru Technological Univ., Hyderabad (India).
For primary bibliographic entry see Field 2F.
W91-03189

3-D STOCHASTIC DISCRETE FRACTURE NETWORK MODEL FOR SIMULATING FLOW AND TRANSPORT THROUGH FRACTURED MEDIA.
Ecole Nationale Superieure des Mines de Paris, Fontainebleau (France). Centre d'Information Geologique.
For primary bibliographic entry see Field 2F.
W91-03190

NEW APPROACH TO TRACER TRANSPORT ANALYSIS: FROM FRACTURE SYSTEMS TO STRONGLY HETEROGENEOUS POROUS MEDIA.
California Univ., Berkeley. Earth Sciences Div.
For primary bibliographic entry see Field 2F.
W91-03191

MODELLING OF ENERGY FORESTRY: GROWTH, WATER RELATIONS AND ECONOMICS.
For primary bibliographic entry see Field 2I.
W91-03198

SIMULATED WATER BALANCE OF A WILLOW STAND ON CLAY SOIL.
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences.
For primary bibliographic entry see Field 2I.
W91-03202

RIVER MEANDERING.
For primary bibliographic entry see Field 2E.
W91-03203

USER'S GUIDE FOR THE UPDATED SMITH-FEDDES MODEL.
Arvin/Calspan Advanced Technology Center, Buffalo, NY.
For primary bibliographic entry see Field 2B.
W91-03228

ADIRONDACK WATERSHED DATA BASE: ATTRIBUTE AND MAPPING INFORMATION FOR REGIONAL ACIDIC DEPOSITION STUDIES.
Oak Ridge National Lab., TN. Environmental Sciences Div.
A. E. Rosen, R. J. Olson, G. K. Gruendling, D. J. Bogucki, and J. L. Malanchuk.
Available from the National Technical Information Service, Springfield, Virginia 22161, as DE89-005682. Price codes: A11 in paper copy, A01 in microfiche. Report no. ORNL/TM--10144, December 1988. 245 p, 43 fig, 4 tab, 37 ref, 3 append. Contract no. DE-AC05-84OR21400.

Descriptors: *Acid rain, *Acid rain effects, *Databases, *Geographic information systems, *Mapping, *Watershed management, Adirondacks, Data interpretation, Environmental protection, Model studies, New York.

The Adirondack Watershed Data Base (AWDB) provides a means to study various watershed attributes that may contribute to increased acidification of Adirondack surface waters, and is a valuable resource for the study of other ecological phenomena. The AWDB consists of digital watershed boundaries and digital geographic data (topography, soils, land cover, etc.), stored within a geographic information system, and watershed/lake attribute data stored in a data management system for 463 Adirondack headwater lakes. Attributes include watershed morphology, physiography, bedrock, soils, land cover, wetlands, disturbances (e.g. cabins, fire, and logging), beaver activity, precipitation, and atmospheric deposition. Over 600 variables are available for each watershed. These data can be combined with water chemistry data and fish community status for regional-scale examinations of watershed attributes that may account for variability and change in water chemistry and fish populations in the Adirondacks. (Fish-PTT)
W91-03234

IMPACT: AN EXPERT SYSTEM FOR ENVIRONMENTAL IMPACT ASSESSMENT.
Westinghouse Savannah River Co., Aiken,SC.
For primary bibliographic entry see Field 6G.
W91-03240

VARIANCES AND COVARIANCES OF THE MAXIMUM ENTROPY ESTIMATORS FOR THE PEARSON TYPE-3 DISTRIBUTION.
Asian Inst. of Tech., Bangkok (Thailand).
H. N. Phien, and V. T. V. Nguyen.
Canadian Journal of Civil Engineering CJCEB8, Vol. 17, No. 4, p 590-596, August 1990. 7 tab, 17 ref, append. Natural Sciences and Engineering Research Council of Canada Grant A6833.

Descriptors: *Entropy, *Flood forecasting, *Flood frequency, *Mathematical studies, *Parameter estimation, *Probability distribution, *Statistical analysis, Data interpretation, Monte Carlo method, Sampling, Simulation analysis.

Although the method of maximum entropy appears to be promising in fitting the Pearson type-3 distribution in flood probability analysis, the sampling properties of the estimators have not been available. The formulas needed for computing the variances and covariances of the parameter estimators and the variance of the T-year event are provided. All needed formulas are derived analytically and related computation schemes are described. Through applications of the developed technique to actual and simulated data, it was found that the efficiency of the method of maximum entropy may be slightly improved when the biased sample variance is used instead of the unbiased one. Simulated results indicate that this procedure can provide good estimated values for the percent standard error, hence for the variance of the T-year event. (Author's abstract)
W91-03308

KNOWLEDGE-BASED EXPERT SYSTEM FOR FLOOD FREQUENCY ANALYSIS.
Queen's Univ., Kingston (Ontario). Dept. of Civil Engineering.
K. C. A. Chow, and W. E. Watt.
Canadian Journal of Civil Engineering CJCEB8, Vol. 17, No. 4, p 597-609, August 1990. 8 fig, 4 tab, 12 ref.

Descriptors: *Data interpretation, *Expert systems, *Flood forecasting, *Flood frequency, *Probability distribution, Canada, Performance evaluation, Simulation analysis, Statistical analysis, Uncertainty.

Single-station flood frequency analysis is an important element in hydrotechnical planning and design. In Canada, no single statistical distribution has been specified for floods: hence, the conventional approach is to select a distribution based on its fit to the observed sample. This selection is not straightforward owing to typically short record lengths and attendant sampling error, magnified influence of apparent outliers, and limited evidence of two populations. Nevertheless, experienced analysts confidently select a distribution for a station based only on a few heuristics. A knowledge-based expert system has been developed to emulate these expert heuristics. It can perform data analyses, suggest an appropriate distribution, detect outliers, and provide means to justify a design flood on physical grounds. If the sample is too small to give reliable quantile estimates, the system performs a Bayesian analysis to combine regional information with station-specific data. The system was calibrated and tested for 52 stations across Canada. Its performance was evaluated by comparing the distributions selected by experts with those given by the developed system. The results indicated that the system can perform at an expert level in the task of selecting distributions. (Author's abstract)
W91-03309

OVERVIEW OF FLOW SIMULATION MODELS IN FRACTURED AQUIFERS.
Indian Inst. of Science, Bangalore.
For primary bibliographic entry see Field 2F.
W91-03312

NONDEFEATIST DERIVATION OF FINITE DIFFERENCE SCHEMES.
Roorkee Univ. (India). Dept. of Earth Sciences.
For primary bibliographic entry see Field 2F.
W91-03313

HYDROGEOLOGY OF THE MIDDLE CHELIFF BASIN (ALGERIA): SIMULATION OF GROUNDWATER FLOWS.
Neuchatel Univ. (Switzerland). Center of Hydrology.
For primary bibliographic entry see Field 2F.
W91-03314

GROUNDWATER BASIN SIMULATION OF MAHI RIGHT BANK CANAL COMMAND AREA, GUJARAT, INDIA.
Punjab Agricultural Univ., Ludhiana (India). Dept. of Soil and Water Engineering.
For primary bibliographic entry see Field 2F.
W91-03319

SIMULATION OF REGIONAL HYDRODYNAMICS IN THE NEYVELI AQUIFER.
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 2F.
W91-03321

GROUNDWATER QUALITY MONITORING: STATISTICAL MODELING.
Kakatiya Inst. of Tech. and Science, Warangal (India).
For primary bibliographic entry see Field 4C.
W91-03338

ANALYSIS OF BREAKTHROUGH CURVES FOR ASSESSING MOVEMENT OF CONTAMINANTS.
Central Soil Salinity Research Inst., Karnal (India).
For primary bibliographic entry see Field 5B.
W91-03340

DISPERSION OF POLLUTANTS IN POROUS MEDIA FLOW ONE-DIMENSIONAL APPROACH.
College of Engineering, Poona (India).
For primary bibliographic entry see Field 5B.
W91-03341

SINGLE-PHASE/TWO-PHASES NUMERICAL MODEL USING NESTED SQUARE MESHES.
Ecole Nationale Superieure des Mines de Paris, Fontainebleau (France). Centre d'Information Geologique.
For primary bibliographic entry see Field 2F.
W91-03343

CLIMATIC CLASSIFICATION FOR QUEENSLAND USING MULTIVARIATE STATISTICAL TECHNIQUES.
Jaffna Univ. (Sri Lanka). Dept. of Geography.
For primary bibliographic entry see Field 2B.
W91-03395

THEORETICALLY DERIVED DISTRIBUTION FOR ANNUAL RAINFALL TOTALS.
For primary bibliographic entry see Field 2B.
W91-03398

RATIONAL APPROACH FOR MODIFYING ROTATIONAL WATER DELIVERY SCHEDULE.
Central Soil Salinity Research Inst., Karnal (India).
For primary bibliographic entry see Field 3F.
W91-03422

PUMP TEST ANALYSIS OF LEAKY AQUIFER.
Roorkee Univ. (India). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-03423

OBSERVABILITY OF SURFACE IRRIGATION ADVANCE.
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W91-03424

ESTIMATION OF SURFACE IRRIGATION PARAMETERS.
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W91-03425

SELF-ADAPTIVE CONTROL OF SURFACE IRRIGATION ADVANCE.
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W91-03426

USING SOIL AND METEOROLOGIC DATA BASES IN UNSATURATED ZONE MODELING OF PESTICIDES.
Environmental Research Lab., Athens, GA.
For primary bibliographic entry see Field 5B.
W91-03446

USE OF COOPERATIVE WEATHER STATION DATA IN CONTEMPORARY CLIMATE RESEARCH.
Illinois State Water Survey Div., Champaign. Climate and Meteorology Section.
For primary bibliographic entry see Field 2B.
W91-03503

USE OF PARAMETER TRANSFORMATIONS IN NONLINEAR, DISCRETE FLOOD EVENT MODELS.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2E.
W91-03542

DEFINITION OF GROUNDWATER FLOW PATTERNS BY ENVIRONMENTAL TRACERS IN THE MULTIPLE AQUIFER SYSTEM OF SOUTHERN ARAVA VALLEY, ISRAEL.
Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
For primary bibliographic entry see Field 2F.
W91-03556

COMPARATIVE EVALUATION OF THE ESTIMATORS OF THE LOG PEARSON TYPE (LP) 3 DISTRIBUTION.
Saint Johns River Water Management District, Palatka, FL. Dept. of Surface Water Programs.
D. V. Rao.
Journal of Hydrology JHYDA7, Vol. 117, No. 1/4, p 369-374, September 1990. 3 tab, 9 ref.

Descriptors: *Data interpretation, *Data processing, *Flood forecasting, *Statistical analysis, *Streamflow forecasting, *Surface water data, Estimating equations, Log distribution, Log transformations, Mathematical analysis, Mixed moments method.

A variation of the mixed moments method for fitting the log Pearson type 3 (LP3) distribution is discussed. Quantiles are the combined expression of the distribution parameters and are of primary interest in design calculations. Three estimation methods (RLMO, MXM1, and MXM3) were compared in a study of the bias and root mean square errors (RMSE) for eight LP3 population cases of the 200-yr maximum event. Among the three methods examined, RLMO estimates had a markedly high bias, whereas MXM1 had, in general, the lowest bias. Minor differences were seen in RMSE; however, overall, MXM1 had the lowest RMSE. Applying criteria for robust estimates, MXM1 was superior to RLMO and MXM3 methods. It is concluded that the MXM1 method possesses the most desirable statistical properties as a fitting method for LP3, compared with other available methods. (MacKeen-PTT)
W91-03557

ADVANCED UTILITY SIMULATION MODEL, ANALYTICAL DOCUMENTATION, STATE LEVEL MODEL (VERSION 1.0).
Illinois Univ. at Urbana-Champaign. Coll. of Engineering.
J. J. Stukel.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-161772/AS. Price codes: A25 in paper copy, AO1 in microfiche. Report No. EPA/600/8-88/071a. January 1989. 578p, 66 fig, 133 tab, 233 ref, 5 append. EPA Cooperative Agreement CR808514.

Descriptors: *Acid rain, *Air pollution, *Electric power industry, *Model studies, *Nitrogen oxides, *Simulation models, *Sulfur dioxide, *Water pollution sources, Chemistry of precipitation, Costs, Forecasting models, United States.

The report is one of 11 in a series describing the initial development of the Advanced Utility Simulation Model (AUSM) by the Universities Research Group on Energy (URGE) and its continued development by the Science Applications International Corporation (SAIC) research team. The AUSM is one of four stationary source emission and control cost forecasting models developed by EPA for the National Acid Precipitation Assessment Program (NAPAP). The AUSM projects air pollution emissions (SO2 and NOx), generating technology types and costs of operation, and combinations of fuels and emission control technologies to simultaneously meet electric demand and emission constraints on a least cost basis for each year through 2010. Thirteen electric demand regions are simulated, and output is provided for each of the 48 contiguous states. The initial version of AUSM, Version 1.0, was delivered by URGE in November 1984 and August 1985. Further development of the AUSM by SAIC between 1985 and 1988 has resulted in the development of Versions 2.0 and 3.0. Reports describing these revisions by SAIC to the initial Version 1.0 of AUSM are also part of this series. (Author's abstract)
W91-03581

SEDIMENT QUALITY VALUES REFINEMENT: VOLUME I. 1988 UPDATE AND EVALUATION OF PUGET SOUND AET (APPARENT EFFECTS THRESHOLD).
PTI Environmental Services, Bellevue, WA.
For primary bibliographic entry see Field 5C.
W91-03583

EVALUATION OF TREND DETECTION TECHNIQUES FOR USE IN WATER QUALITY MONITORING PROGRAMS.
Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 7B.
W91-03584

CASE STUDY EVALUATION OF SATELLITE-DERIVED RAINFALL ESTIMATES AND THEIR APPLICATION TO NUMERICAL MODEL PRECIPITATION FORECAST VERIFICATION.
National Weather Service Forecast Office, Milwaukee, WI.
For primary bibliographic entry see Field 2B.
W91-03600

GROUND WATER POLLUTION TRANSPORT: MODEL STUDIES (JAN 75-MAR 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 10C.
W91-03604

INTRODUCTION TO MODELING OF TRANSPORT PHENOMENA IN POROUS MEDIA.
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-03654

DETERMINATION OF AN UPPER LIMIT DESIGN RAINSTORM FOR THE COLORADO RIVER BASIN ABOVE HOOVER DAM.
Morrison-Knudsen Engineers, Inc., Denver, CO.
For primary bibliographic entry see Field 2B.
W91-03664

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS PROVINCE, MISSOURI, ARKANSAS, KANSAS AND OKLAHOMA--SPRINGFIELD PLATEAU AQUIFER.
Geological Survey, Rolla, MO. Water Resources Div.
J. L. Imes.
Available from Books and Open File Reports Section, USGS Box 25425, Denver, CO 80225. USGS Hydrologic Investigations Atlas HA-711-G, 1990. 3p, 3 maps, 6 ref.

Descriptors: *Arkansas, *Geohydrology, *Groundwater budget, *Kansas, *Maps, *Missouri, *Oklahoma, *Springfield Plateau Aquifer, Aquifer systems, Groundwater quality, Groundwater yield, Hydraulic conductivity, Hydrologic data collections, Regional Aquifer System Analysis, Saline-freshwater interfaces, Stratigraphy.

An investigation of the geohydrologic system in the Ozark Plateaus province has been made as part of the Central Midwest Regional Aquifer-System Analysis, a major study that encompasses parts of 10 states. The stratigraphic relationships among the primary geohydrologic units in the Ozark Plateaus province are discussed in Chapter A of this Hydro-

logic Investigation Atlas series, which focuses on one of those geohydrologic units, the Springfield Plateau aquifer. The Springfield Plateau aquifer, widely used in the south-western part of the Ozark Plateaus province as a source for domestic-, and stock-water, is a sequence of Mississippian Plateaus aquifer system. To the west and south, the Springfield Plateau aquifer thickens abruptly at the edge of the Salem Plateau and at the edge of small, isolated outcrops of stratigraphically lower geohydrologic units, then maintains a relative uniform thickness of 100 to 400 ft throughout the Ozark Plateaus province. The aquifer gradually thickens to the northwest and is missing in the Springfield Plateau in Johnson, Henry, and St. Clair Counties, Missouri. Along the perimeter of the Ozark Plateaus province, the potentiometric surface of geologic units that comprise the Springfield Plateau aquifer is greatly affected by topography. In west-central Missouri and eastern Kansas, where the Springfield Plateau aquifer crops out in about one-third of the Ozark Plateaus province, the aquifer's freshwater to the west of the Ozark Plateaus province is depicted by 1,000 and 2,000 mg/L dissolved solids. Little hydrologic data are available for the Springfield Plateau aquifer in northern Arkansas. In Ste. Genevieve County, Missouri, the hydraulic gradient in geohydrologic units stratigraphically equivalent to the Springfield Plateau aquifer is northeast toward the Mississippi River where groundwater discharges from the rocks. A saline water and freshwater transition zone extending southeast through St. Louis County indicates the mixing zone between the freshwater flow system in the Ozark Plateaus province and a saline water flow system to the northeast. (See W91-03666 thru W91-03668) (Lantz-PTT)
W91-03665

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS PROVINCE, MISSOURI, ARKANSAS, KANSAS, AND OKLAHOMA--WESTERN INTERIOR PLAINS CONFINING SYSTEM.
Geological Survey, Rolla, MO. Water Resources Div.
J. L. Imes.
Available from Books and Open File Reports Section, USGS Box 25425, Denver, CO 80225. USGS Hydrologic Investigations Atlas HA-711-H, 1990. 3p, 3 maps, 7 ref.

Descriptors: *Arkansas, *Geohydrology, *Groundwater budget, *Kansas, *Maps, *Missouri, *Oklahoma, *Western Interior Plains Confining Syste, Aquifer systems, Aquifers, Confined aquifers, Groundwater quality, Groundwater resources, Groundwater yield, Hydraulic conductivity, Hydrologic data collections, Regional Aquifer System Analysis, Stratigraphy.

An investigation of the geohydrolgoic system in the Ozark Plateaus province, has been made as part of the Central Midwest Regional Aquifer-System Analysis, a major study that encompasses parts of 10 States. The stratigraphic relationship among the primary geohydrologic units in the Ozark Plateaus province is discussed in Chapter A of this Hydrologic Investigations Atlas. This chapter focuses on the Western Interior Plains confining system, geohydrologic unit that confines the western and southern edges of the Ozark Plateaus aquifer system. The Western Interior Plains confining system is an extremely thick (as much as 20,000 ft) and areally extensive geohydrologic unit that extends from the Rocky Mountains to western Missouri and northern Arkansas. Confining layers usually, but not always, contain significant quantities of shale, a relatively impermeable material. Within the thick Western Interior Plains confining system, many formations of younger geologic age than those that are present along the boundaries of the Ozark Plateaus province exist. Because the Western Interior Plains confining system is a thick, complex sequence of interbedded permeable sandstone and limestone layers and large, relatively impermeable shale layers, the distribution of hydraulic heads within the confining system varies both vertically and laterally. Movement of groundwater through the confining system is slow and complex. Groundwater levels in the upland areas tend to be as much as 100 ft lower than the average land-surface altitude. In the northwestern part of the Ozarks, groundwater in the weathered surface layer of the confining system primarily moves toward the Missouri and Marais des Cygnes River valleys. Well recovery tests on 14 wells located near the border of the Ozark Plateaus in southwestern Missouri show a range of yields from 1 to 40 gallons per minute. Generally, well yields tended to decrease from east to west in this area. The dissolved solids concentrations of water in the Western Interior Plains confining system increases to the west, generally exceeding 100,000 mg/L at the west edge of the map area. (See also W91-03665, W91-03667, and W91-03668) (Lantz-PTT)
W91-03666

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS PROVINCE, MISSOURI, ARKANSAS, KANSAS, AND OKLAHOMA--ST. FRANCOIS AQUIFER.
Geological Survey, Rolla, MO. Water Resources Div.
J. L. Imes.
Available from Books and Open File Reports Section, USGS Box 25425, Denver, CO 80225. USGS Hydrologic Investigations Atlas HA-711-C, 1990. 2p, 3 maps, 3 ref.

Descriptors: *Arkansas, *Geohydrology, *Groundwater budget, *Kansas, *Maps, *Missouri, *Oklahoma, *St Francois Aquifer, Aquifers, Groundwater quality, Groundwater resources, Groundwater yield, Hydraulic conductivity, Hydrologic data collections, Regional Aquifer System Analysis, Sediments, Stratigraphy.

An investigation of the geohydrologic system in the Ozark Plateau province has been made as part of the Central Midwest Regional Aquifer-System Analysis, a major study of the regional aquifer system in parts of 10 States. Because a large quantity of fresh groundwater is available in aquifers underlying the Ozark Plateaus province, a subregional project has been established to study the geohydrologic units of this area in more detail than is practical in the regional study. The stratigraphic relationship among the primary geohydrologic units in the Ozark Plateaus province is discussed in Chapter A of this Hydrologic Investigations Atlas series. The chapter focuses on the St. Francois aquifer, a geohydrologic unit within the Ozark Plateaus aquifer system underlying the Ozark Plateaus province. The St. Francois aquifer is thickest (> 1,000 ft) in the eastern part of the Ozark Plateaus province near the Mississippi Alluvial Plain. The aquifer generally is between 300 and 500 ft thick immediately west and southwest of the St. Francois Mountains and < 300 ft thick in the western southwestern, and southern parts of the province. The sediments that form the St. Francois aquifer are conformable with less permeable sediments of the overlying Davis Formation. Lamotte Sandstone and Bonneterre Dolomite form the St. Francois aquifer in the eastern two-thirds of the province. The Lamotte generally is a well-sorted sandstone with some silt, locally grading into arkose and conglomerate. Estimates of hydraulic conductivity in the immediate vicinity of the St. Francois Mountains, using specific capacity data, range from 0.0001 ft/sec to 0.000001 ft/sec and tend to decrease away from the mountains. The St. Francois aquifer is used as a source of water primarily at its outcrop area in the St. Francois Mountains. Water quality in this region is adequate for most uses, and dissolved solids concentrations range from about 220 to 450 mg/L. Those wells that are open to a significant thickness of Lamotte Sandstone usually have yields ranging from 100 to 500 gal/min. Depth to water in the outcrop area ranges from ground level to about 150 ft. (See also W91-03665, W91-03666, and W91-03668) (Lantz-PTT)
W91-03667

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS PROVINCE, MISSOURI, ARKANSAS, KANSAS, AND OKLAHOMA.
Geological Survey, Rolla, MO. Water Resources Div.
J. L. Imes.
Available from Books and Open File Reports Section, USGS Box 25425, Denver, CO 80225. USGS Hydrologic Investigations Atlas HA-711-A, 1990. 1p, 2 fig, 1 map, 5 ref.

Descriptors: *Aquifer systems, *Arkansas, *Geohydrology, *Kansas, *Maps, *Missouri, *Oklahoma, *Ozark Plateau, Hydrologic data collections, Ozark Aquifer, Regional Aquifer System Analysis, Springfield Plateau Aquifer, St Francois Aquifer, Stratigraphy.

An investigation of the geohydrologic system in the Ozark Plateaus province has been made as part of the Central Midwest Regional Aquifer-System Analysis, a major study of the regional aquifer system in parts of 10 states. The stratigraphic and geologic relationships among the primary geohydrologic units in and adjacent to the Ozark Plateaus is depicted in this atlas (Chapter A). This is the first of a series of chapters (A-H) that includes maps of the altitude of the top, thickness, potentiometric surface, and percentage-of-shale content of individual geohydrologic units. The geohydrologic system in and adjacent to the Ozark Plateaus province can be divided into eight major regional units on the basis of relative rock permeability and well yields. These geohydrologic units consist of geologic units ranging in age from Precambrian (igneous and metamorphic rocks) to Quaternary (alluvial deposits). Five of the units, the St. Francois aquifer, St. Francois confining unit, Ozark aquifer, Ozark aquifer system (stratigraphic column). The approximate location of the boundary of the mainly freshwater Ozark Plateaus aquifer system has been identified using potentiometric-head and dissolved solids concentration data from the system's component geohydrologic units. Geohydrologic units that comprise the Ozark Plateaus aquifer system crop out in a concentric pattern centered on the St. Francois Mountains. The three lowest geohydrologic units crop out only in the immediate vicinity of the St. Francois Mountains. The Ozark aquifer is the largest aquifer, both in areas of outcrop and thickness, and the most important source of freshwater in the Ozark Plateaus. The geohydrologic section, which trends across the Ozark Plateaus province from west to east, passing through the St. Francois Mountains, depicts the stratigraphic position and relative thicknesses of the units. The geohydrologic units in and adjacent to the Ozark Plateaus province are: (1) basement confining unit (Chapter B); (2) St. Francois aquifer (Chapter C); (3) St. Francois confining unit (Chapter D); (4) Ozark aquifer (Chapter E); (5) Ozark confining unit (Chapter F); (6) Springfield Plateau aquifer (Chapter G); (7) Western Interior Plains confining system (Chapter H); and (8) Post-Paleozoic sediments. (See also W91-03665 thru W91-03667)
W91-03668

HYDROGEOLOGY OF THE GALLUP SANDSTONE IN THE SAN JUAN STRUCTURAL BASIN, NEW MEXICO, COLORADO, ARIZONA AND UTAH.
Geological Survey, Albuquerque, NM. Water Resources Div.
J. M. Kernodle, G. W. Levings, S. D. Craigg, and W. L. Dam.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Hydrologic Investigations Atlas HA-720-H, 1989. 2p, 14 fig, 3 tab, 31 ref.

Descriptors: *Arizona, *Colorado, *Gallup Sandstone, *Geohydrology, *Groundwater resources, *Maps, *New Mexico, *Utah, Dissolved solids, Groundwater budget, Groundwater quality, Hardness, Hydrologic data collections, Natural gas, Oil fields, Regional Aquifer System Analysis, Sulfates, Water quality.

This report is one in a series resulting from the USGS's Regional Aquifer-System Analysis (RASA) study of the San Juan structural basin that began in October 1984. The purposes of the study are to: (1) define and evaluate the aquifer system; (2) assess the effects of past, present, and potential groundwater use on aquifers and streams; and (3) determine the availability and quality of ground-

water. The Gallup Sandstone is one of the primary water-bearing units in the regional aquifer system. Water wells generally are near the western and southern margins of the basin. Oil and gas test holes have penetrated the Gallup Sandstone near the northeast edge of the main body. Water is produced in several of these oil or gas fields as a secondary product or for reinjection in secondary recovery and repressurization projects. Water in the Gallup Sandstone occurs under both water table and artesian conditions. Recharge to the aquifer is from infiltration of precipitation and streamflow on outcrops and from vertical leakage of water through confining beds. The reported or measured discharge from 32 water wells completed in the Gallup Sandstone ranges from 1 to 645 gal/min (gpm) and the median is 40 gpm. The specific capacity of 13 of these wells ranges from 0.12 to 2.10 gpm/ft of drawdown and the median is 0.46 gpm/ft of drawdown. Physical and chemical data used to describe the quality of water in the Gallup Sandstone are available for 1948 to 1986. The concentrations of dissolved sulfate exceeded the secondary drinking water standard of 250 mg/L in 48 of 77 samples; the median value is greater than the standard. Concentrations of dissolved chloride generally are small; however, in one sample chloride exceeded the standard of 250 mg/L. The concentration of dissolved solids in water the Gallup Sandstone ranged from 210 to 6,000 mg/L. Water from the Gallup generally is hard to very hard; 39% of the samples were classified as very hard. (Lantz-PTT)
W91-03669

POTENTIAL FOR AQUIFER COMPACTION, LAND SUBSIDENCE, AND EARTH FISSURES IN AVRA VALLEY, PIMA AND PINAL COUNTIES, ARIZONA.
Geological Survey, Tucson, AZ. Water Resources Div.
S. R. Anderson.
Available from Books and Open File Reports Section, USGS Box 25425, Denver, CO 80225. USGS Hydrologic Investigations Atlas HA-718, 1989. 3p, 9 fig, 56 ref.

Descriptors: *Aquifer characteristics, *Arizona, *Avra Valley, *Compaction, *Groundwater mining, *Groundwater resources, *Maps, *Subsidence, Aquifers, Geohydrology, Geologic fissures, Geologic fractures, Groundwater level, Groundwater recharge, Hydrologic data collections, Water level.

Avra Valley is a large north-trending alluvial basin about 15 mi west of Tucson in Pima and Pinal Counties, Arizona. Two major ephemeral streams, the Santa Cruz River and Brawley Wash, drain the area. These streams and their tributaries provide a source of recharge to an extensive alluvial aquifer that underlies the valley floor. The aquifer consists of interbedded gravel, sand, silt, and clay and contains a vast quantity of groundwater. Aquifer compaction, land subsidence, and earth fissures can severely damage or affect the functional capability of manmade features. Aquifer compaction may damage wells, differential land subsidence may adversely affect structures such as sewers and irrigation water supply systems that are dependent on gravity for their operation, and fissures may damage engineered structures. In addition, compaction and subsidence can seriously reduce the groundwater storage capacity of the aquifer, and fissures may provide a direct path for the rapid movement of contaminants from the land surface to the aquifer. Damage that results from compaction, subsidence, and fissuring has occurred in the Eloy-Picacho area northwest of Avra Valley. Survey data indicate that 120 sq mi subsided about 7 to 12.5 ft from 1952 to 1977. Many earth fissures have opened in this area; the fissures commonly are more than 1,000 ft long and generally surround areas of large water level decline and subsidence. This report describes geohydrologic characteristics of Avra Valley that may contribute to potential aquifer compaction, land subsidence, and earth fissures. The quantitative evaluation of potential land subsidence in this report is presented as an interim land-use and water-use planning tool pending acquisition and study of additional data. The evaluation also assumes that water level declines in the aquifer will continue. Socio-economic factors that may reduce groundwater withdrawals, and thus the potential for compaction and subsidence in Avra Valley, were not evaluated. These factors include the effects of the 1980 Arizona Groundwater Management Act that regulates withdrawals of groundwater in major agricultural areas, the importation of Colorado River water by the Central Arizona Project, and the probable increased reuse and reclamation of sewage effluent. (Lantz-PTT)
W91-03670

HYDROLOGIC CHARACTERISTICS OF SOILS IN THE HIGH PLAINS, NORTHERN GREAT PLAINS, AND CENTRAL TEXAS CARBONATES REGIONAL AQUIFER SYSTEMS.
Geological Survey, Lincoln, NE. Water Resources Div.
J. T. Dugan, R. D. Hobbs, and L. A. Ihm.
Available from Books and Open File Reports Section, USGS Box 25425, Denver, CO 80225. USGS Hydrologic Investigation Atlas HA-714, 1990. 1p, 2 tab, 1 map, 33 ref.

Descriptors: *Aquifer systems, *Maps, *Soil properties, *Soil water, *Texas, Carbonates, Classification, Hydrologic data collections, Permeability, Regional aquifers, Seasonal variation, Slopes, Soil moisture retention, Soil profiles, Water table.

Certain physical characteristics of soils; namely, permeability, available water capacity, slope, and thickness, have a measurable effect on the hydrologic responses of soils in the High Plains, Northern Great Plains, and Central Texas Carbonates Regional Aquifer systems. The study, which includes all or parts of 11 States, describes the relation between the hydrologic characteristics of the soils and those environmental factors that affect the development and distribution of the soils. In addition to providing a quantitative basis for evaluating the hydrologic responses of the soils, the methodology serves as a tool for consolidating the soil groups of the study area into a more manageable number. The 161 soil mapping units identified in the study area are consolidated into 39 hydrologic soil groups and range of values are presented for: (1) average permeability of the soil profile; (2) average available water capacity of the soil; and (3) average maximum slope. Additionally, the depth to seasonal high water table is indicated as $>$ or $<$ 6 ft and thickness of the soil profiles as $>$ or $<$ 60 inches. The spatial patterns of the soils classified according to their quantifiable hydrologic characteristics will serve as an integral component in the analysis of actual evapotranspiration, consumptive irrigation requirements, and potential groundwater recharge of the study area. (Lantz-PTT)
W91-03671

MODELING NONPOINT POLLUTION AT THE WATERSHED LEVEL WITH THE AID OF A GEOGRAPHIC INFORMATION SYSTEM.
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
For primary bibliographic entry see Field 4D.
W91-03734

BIAS IN LOG-TRANSFORMED FREQUENCY DISTRIBUTIONS.
Proctor and Redfern Group, Toronto (Ontario).
B. G. Wilson, B. J. Adams, and B. W. Karney.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 19-37, October 1990. 5 fig, 2 tab, 22 ref.

Descriptors: *Data interpretation, *Flood forecasting, *Flood frequency, *Frequency distribution, *Hydrologic data, *Mathematical equations, *Numerical analysis, *Statistics, Monte Carlo method, Parametric hydrology, Simulation analysis, Wave height.

Estimates of the parameters of frequency distributions are often derived from the logarithms of a series of measured data rather than from the original series itself. This is common practice, for example, in estimating flood frequencies from measured streamflow data, extreme wave frequencies from wave height data, as well as in many other contexts. This procedure leads to biased estimates of the moments and quantiles of the frequency distribution in arithmetic space. This bias is the result of the nonlinear inverse transformation process. The case of the two parameter lognormal distribution was examined in detail and analytical expressions for the bias was derived. The bias introduced by the logarithmic transformation is dependent on the sample size and the population parameters. The derived analytical expressions for bias agree with the results of a series of Monte Carlo simulations. (Author's abstract)
W91-03738

SLIDING MAXIMA.
Agricultural Univ., Wageningen (Netherlands). Dept. of Mathematics.
M. A. J. van Montfort.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 77-85, October 1990. 2 tab, 11 ref.

Descriptors: *Data interpretation, *Mathematical studies, *Numerical analysis, *Statics, *Time series analysis, Estimating equations, Hydrologic data collections, Probable maximum precipitation, Statistical analysis.

The statistics of extremes play an important role in quantitative hydrology. In practice, the distribution of maxima in time periods of a specified length and a sliding starting point is often required, e.g. the maximum precipitation amount in January in a sliding period of 24 hours, while data of observation days only are available. The notation 'A-maxima' is used for maxima in a time period with sliding starting point, where A is an abbreviation of arbitrary or any. 'F-maxima' refer to fixed starting points. Inference on A-maxima is usually based on F-maxima and a partly empirical factor (the 'Hershfield coefficient'); the problem is how to use F-maxima for inference on A-maxima. The distribution of a maximum in a time interval of fixed length with a sliding starting point was estimated from maxima over periods with fixed starting points. Special attention was paid to a specific quantile of the distribution of A-maxima; the 0.98-quantile, related to a return period of 50 years, was chosen for a data set of 58 years. The results were related to estimations based on F-maxima. Support was found for the Hershfield coefficient, but knowledge of this coefficient or continuous recording is not a prerequisite. (Fish-PTT)
W91-03741

SIMULATION OF SALTWATER INTRUSION IN THE NORTHERN GUAM LENS USING A MICROCOMPUTER.
Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
For primary bibliographic entry see Field 2F.
W91-03742

STOCHASTIC MODEL OF THE INTERNAL STRUCTURE OF CONVECTIVE PRECIPITATION IN TIME AT A RAINGAUGE SITE.
Universidad Politecnica de Valencia (Spain). Dept. of Hydraulic and Environmental Engineering.
For primary bibliographic entry see Field 2B.
W91-03744

ASSESSING HYDROLOGIC MODEL NONLINEARITY USING RESPONSE SURFACE PLOTS.
Newcastle Univ. (Australia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W91-03745

SAMPLING ERRORS FOR RAINGAUGE-DERIVED MEAN AREAL DAILY AND MONTHLY RAINFALL.
Hydrological Research Inst., Pretoria (South Africa).
For primary bibliographic entry see Field 2B.
W91-03746

PARAMETER TRANSFERABILITY FOR A DAILY RAINFALL DISAGGREGATION MODEL.
National Weather Service, Johnson City, NY.
For primary bibliographic entry see Field 2B.
W91-03749

ESTIMATION OF THE HYDRAULIC PARAMETERS OF THE RIO-MAIOR AQUIFER IN PORTUGAL BY USING STOCHASTIC INVERSE MODELING.
California Univ., Berkeley. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-03752

TRANSPORT IN HETEROGENEOUS POROUS FORMATIONS: 1. TIME-DEPENDENT CONVECTIVE DISPERSION.
Centre National de la Recherche Scientifique, Toulouse (France). Inst. de Mecanique des Fluides.
J. Valiantzas, and C. Thirriot.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 311-327, October 1990. 10 fig, 17 ref.

Descriptors: *Convection, *Dispersion, *Groundwater movement, *Model studies, *Porous media, *Solute transport, *Stochastic models, Analysis of variance, Correlation analysis, Dispersion coefficient, Flow velocity, Heterogeneity, Hydraulic conductivity, Numerical analysis, Probabilistic process, Seepage, Statistical analysis.

A stochastic Lagrangian model was used to obtain the time evolution of the convective dispersion coefficient in heterogeneous porous formations. By using a probabilistic approach, the correlation of Lagrangian velocities was related to the spatial correlation of the Eulerian velocities. This model is an extension of those previously developed. The statistical parameters of the seepage velocity field were related to the heterogeneous structure using Monte Carlo numerical simulations. In addition, Monte Carlo simulations of the convective transport of a tracer in two-dimensional and three-dimensional heterogeneous domains were obtained. Three different types of correlation functions of the random conductivity field were examined. The investigation of the generated velocity field leads to the conclusion that the statistical characteristics of the velocity field are independent of the particular form of correlation of conductivities examined. Variances depend essentially on the standard deviation of the log conductivities while the correlation function depends only on the integral scale of the conductivity field. The comparison of numerical with theoretical results is favorable. (See also W91-03755) (Fish-PTT)
W91-03755

TRANSPORT IN HETEROGENEOUS POROUS FORMATIONS: 2. TIME-DEPENDENT DOUBLE DISPERSION.
Centre National de la Recherche Scientifique, Toulouse (France). Inst. de Mecanique des Fluides.
J. Valiantzas, and C. Thirriot.
Journal of Hydrology JHYDA7, Vol. 118, No. 1/4, p 329-342, October 1990. 9 fig, 15 ref, append.

Descriptors: *Convection, *Dispersion, *Groundwater movement, *Model studies, *Porous media, Correlation analysis, Darcys law, Dispersion coefficient, Energy transfer, Flow velocity, Heterogeneity, Hydraulic conductivity, Mass transfer, Numerical analysis, Probabilistic process, Spatial distribution, Stochastic models.

The analysis of the mechanisms governing the phenomenon of dispersion in porous media, which is directly related to mass and energy transfer, is common subject of research. The global effect of the local dispersion on the pure convective fluctuations has been studied, using two-dimensional and three-dimensional theory for field-scale time evolution of the effective dispersion in heterogeneous porous media. A probabilistic approach was used to obtain the time correlation of Lagrangian velocities as a function of the spatial correlation of Eulerian velocities and the local tensor of dispersion. The model leads to results which differ from earlier theoretical results. The convective-dispersion equation assumed valid at the local Darcy scale, was solved numerically by the method of characteristics in a rectangular domain where the hydraulic conductivity is a stochastic function of space (isotropic or anisotropic), for two different types of correlation functions already studied. The results of numerical simulations compare favorably with those obtained from the theoretical model. (See also W91-93754) (Author's abstract)
W91-03756

SENSITIVITY ANALYSIS OF '2D-FED,' A MODEL FOR SEAWATER ENCROACHMENT IN LEAKY COASTAL AQUIFERS.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W91-03757

MATHEMATICAL MODELS FOR LONG-TERM PREDICTION OF MOUNTAINOUS RIVER RUNOFF: METHODS, INFORMATION AND RESULTS.
Sredneaziatskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Inst., Tashkent (USSR).
For primary bibliographic entry see Field 2E.
W91-03840

COMPARISON OF OBJECTIVE AND SUBJECTIVE PRECIPITATION PROBABILITY FORECASTS: THE SUFFICIENCY RELATION.
Oregon State Univ., Corvallis. Dept. of Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W91-03850

STORM WATER MANAGEMENT MODEL FOR URBAN AREAS IN KUWAIT.
Kuwait Univ., Safat. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W91-03852

DISTRIBUTED DYNAMIC WATERSHED MODEL.
Texas A and M Univ., College Station.
For primary bibliographic entry see Field 2E.
W91-03854

RUNOFF VOLUME ESTIMATION USING GIS TECHNIQUES.
National Park Service, Denver, CO. Denver Service Center.
For primary bibliographic entry see Field 2A.
W91-03856

LINEAR PROGRAMS FOR NONLINEAR HYDROLOGIC ESTIMATION.
California Univ., Santa Barbara. Dept. of Geography.
For primary bibliographic entry see Field 2E.
W91-03859

COMPARISON OF MODELS PREDICTING GROUND WATER LEVELS ON HILLSIDE SLOPES.
Stevens Inst. of Tech., Hoboken, NJ. Dept. of Civil, Environmental and Coastal Engineering.
For primary bibliographic entry see Field 2F.
W91-03860

OPTIMAL BATHYMETRY OF TYRRHENIAN SEA BY STOCHASTIC INTERPOLATORS.
Padua Univ. (Italy). Dipt. di Metodi e Modelli Matematici per le Scienze Applicate.
For primary bibliographic entry see Field 5B.
W91-03862

ADDITIONAL ANALYSIS OF PEAK-VOLUME RELATIONS AND STANDARDIZATION PROCEDURES.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-03863

PRACTICAL ACCOUNT OF INSTABILITIES IN IDENTIFICATION PROBLEMS IN GROUNDWATER SYSTEMS.
Australian National Univ., Canberra. Centre for Mathematical Analysis.
C. R. Dietrich, G. N. Newsam, R. S. Anderssen, F. Ghassemi, and A. J. Jakeman.
BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 11, No. 2/3, p 273-284, 1990. 2 fig, 23 ref, append.

Descriptors: *Data interpretation, *Mathematical models, *Model studies, *Numerical analysis, *Parametric hydrology, Algorithms, Aquifer characteristics, Aquifer systems, Geohydrology, Input-output analysis, Simulation analysis.

The construction of models requiring the identification of parameters, such as groundwater models, often leads to numerical instabilities. Errors induced by these instabilities may actually increase with improved data collection and model resolution. It is, therefore, important to properly understand the origin and nature of such instabilities, and to allow for their effect. There are important differences between the problems of identifying parameters or inputs of a geohydrological system from output observations, and the problem of simulating future outputs for given inputs and parameters. While both problems involve use of the mathematical model and gathered data to infer the form of some unknown physical quantity, there is a great difference in both the amount of information on the solution that can be gleaned from the model and data, and in the performance of numerical methods that do the gleaning. Therefore, in simulation, reasonably accurate knowledge of the data and model is enough to construct a reasonably accurate representation of the full solution. However, in most identification problems, while exact knowledge of the data and model is sufficient to reconstruct the full solution, in the presence of data or model errors an accurate reconstruction of the full solution is no longer possible. The data and model now only suffice to recover a finite component of the solution to within some specified accuracy. The complementary component is not identifiable from the available information; its determination requires knowledge from some other source. The identifiable component is likely to be smooth and slowly varying; it will not give accurate estimates of point values of the solution. Finally, the sensitivity of reconstructions to error requires that careful analyses be carried out before numerical solutions are calculated; they are essential for assessment of the reliability of the numerical results. (Fish-PTT)
W91-03901

EFFECT OF SENSOR ERROR ON INTERPRETATION OF LONG-TERM WATER-LEVEL DATA.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 7B.
W91-03918

ANALYSIS TECHNIQUE FOR MULTILEVEL AND PARTIALLY PENETRATING SLUG TEST DATA.
South Carolina Univ., Columbia. Dept. of Civil Engineering.
M. A. Widdowson, F. J. Molz, and J. G. Melville.
Ground Water GRWAAP, Vol. 28, No. 6, p 937-945, November/December 1990. 8 fig, 5 tab, 13 ref. EPA assistance agreement CR813647010.

Descriptors: *Aquifer characteristics, *Aquifer testing, *Finite element method, *Groundwater movement, *Numerical analysis, *Pumping tests, *Slug tests, Anisotropy, Confined aquifers, Data interpretation, Flow models, Hydraulic conductivity, Unconfined aquifers, Well construction, Well screens.

The multilevel slug test is a technique that provides data for determining the local value of hy-

draulic conductivity at a specific elevation. However, existing data analysis techniques developed for fully-screened and/or partially-screened slug tests and packer slug tests are not adequate for application to the general multilevel case. Through the application of a numerical flow model to the problem, a new means to analyze multilevel slug test data has been developed. Simulations performed for both confined and unconfined cases using a finite-element model yield values of dimensionless discharge for a complete range of multilevel slug test geometries. Effects of anisotropy and location of instrumentation relative to aquifer boundaries were also considered. The method allows for values of horizontal hydraulic conductivity to be determined directly from slug test data, and compares favorably with distributions inferred from single-well tracer test data and borehole flowmeter tests. An important consideration in multilevel slug testing is well design and construction; permeability of material around the borehole will influence hydraulic response either due to clogging or vertical channeling through the borehole. It is noted that the data analysis techniques will not compensate for the influence of these effects. (Author's abstract)
W91-03919

NUMERICAL GENERATION OF FLOW NETS--THE FLOWNS MODEL.
North Carolina State Univ. at Raleigh. Dept. of Civil Engineering.
W. Bramlett, and R. C. Borden.
Ground Water GRWAAP, Vol. 28, No. 6, p 946-950, November/December 1990. 3 fig, 1 tab, 10 ref. NSF Grant No. CES-8708959; EPA assistance agreement CR812808-01-0.

Descriptors: *Computer models, *Computer programs, *Finite difference methods, *Flow nets, *Groundwater movement, *Model studies, Anisotropy, Contours, Flow equations, Fluctuations, Heterogeneity, Hydraulic conductivity, Laplace equation, Mathematical equations, Numerical analysis, Simulation analysis.

A simple-to-use computer program (FLOWNS) has been developed for simply and efficiently generating flow nets for a wide variety of situations. The program uses a rectangular coordinate system and allows heterogeneous, anisotropic conditions with any combination of constant potential or constant flux boundaries. Internal no-flow boundaries can be approximated by setting the hydraulic conductivities at these locations close to zero. The FLOWNS code was compared with an existing analytical solution. This comparison demonstrated that the program can generate very accurate results, although a fine grid will be necessary when simulating heterogeneous conditions. The program is limited by computational speed for smaller personal computers. Simulations can be expected to require from less than a minute to several hours on an IBM 386 depending on the problem complexity. A contouring program is required to generate the final stream and equipotential lines. Details of the model structure, input and output formats, and example input files are provided in the program documentation, available on 5.25-inch diskettes. (Author's abstract)
W91-03920

8. ENGINEERING WORKS

8A. Structures

INTAKE STRUCTURE OPERATION STUDY: ELK CREEK DAM, OREGON.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
S. E. Howington.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report No. HL-90-16, September 1990. 51 p, 19 fig, 1 tab, 12 ref.

Descriptors: *Elk Creek Dam, *Hydraulic models, *Intakes, *Model studies, *Multipurpose reservoirs, *Reservoir operation, Flood control, Oregon, Reservoir fisheries, Rogue River Basin, Selective withdrawal.

Elk Creek Dam, under construction in Rogue River Basin, Oregon, will be operated for multiple purposes including flood control and fish and wildlife enhancement. Flood control will dictate the quantity of water released. Selective withdrawal will be used to control the dam's release water temperature, which is important to the anadromous fishery in the Rogue River. When selective withdrawal occurs through more than one level of intakes, the unique, single-wet-well intake structure will resemble an intake manifold in a density stratified fluid. To operate the structure effectively for release temperature, the site specific characteristics of selective withdrawal and simultaneous, multilevel withdrawal were required. A 1:20-scale physical model of the unique intake structure and near field topography was built and tested. The model was also employed to detect any hydraulic instabilities characterized by pressure fluctuations within the structure. The testing indicated no hydraulic instabilities and produced reasonable site-specific descriptions of selective withdrawal and simultaneous, multiple-level withdrawal. From these data, an existing one dimensional curve, mathematical reservoir model was modified to predict, from total discharge, a release temperature objective, and in-lake temperature distribution the intake gate openings that will achieve the desired release temperature. (Author's abstract)
W91-03012

NOGALES WASH AND TRIBUTARIES. FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT.
Army Engineer District, Los Angeles, CA.
For primary bibliographic entry see Field 4A.
W91-03030

RIVER INTAKE WORKS FOR A HYDROELECTRIC PLANT IN PAPUA NEW GUINEA.
Klohn Leonoff Ltd., Richmond (British Columbia).
P. S. McCreath, C. R. Neill, L. F. Sawatsky, and M. C. Mannerstrom.
Canadian Journal of Civil Engineering CJCEB8, Vol. 17, No. 4, p 578-589, August 1990. 12 fig, 1 tab, 6 ref.

Descriptors: *Hydroelectric plants, *Intakes, *Mining, *Mountain streams, *Papua New Guinea, Design criteria, Diversion structures, Model studies, New Guinea, Performance evaluation, Weirs.

The Ok Tedi mining development in Papua New Guinea is served by a 50 MW hydroelectric plant completed in 1988. The plant draws water from a run-of-river intake on the Ok Menga, a torrential mountain stream in tropical rain forest subject to frequent flash floods and carrying substantial sediment loads. Design and construction of a diversion weir and intake posed a number of severe problems, such as difficult access, the torrential and flashy nature of the river flows, severe constraints on location due to unstable banks and substrata, and uncertain loads of sediment and debris. Site investigations of a hydrotechnical nature included monitoring of precipitation, streamflow and flood levels, sampling of suspended sediment, and special measurements of bed material and bed load. On the basis of these investigations, preliminary concepts were developed for a diversion weir and intake chamber. A hydraulic model was then constructed to examine alternative forms of weir construction and to study the hydraulic behavior of various intake chamber designs with special attention to exclusion and ejection of coarse sediment. The final design was based largely on the indications of the model study. Initial operating experience generally confirmed the validity of the design, although one or two problems arose that were associated with organic debris and with excessive inflow of coarse sediment due to inexperienced operation. Relatively minor changes were made in operational procedures and equipment to remedy these problems. (Author's abstract)
W91-03307

LOCAL OPTIMAL CONTROL OF IRRIGATION CANALS.
Wyoming Univ., Laramie. Dept. of Agricultural Engineering.
J. M. Reddy.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 5, p 616-631, September/October 1990. 7 fig, 10 ref, append.

Descriptors: *Automation, *Drainage engineering, *Irrigation canals, *Irrigation engineering, *Mathematical models, Continuity equation, Finite difference methods, Flow rates, Hydraulic gates, Momentum equation, Open-channel flow, Optimization.

Dependability of water supply can be achieved through improved operation of the primary and secondary canals. This improvement in operation can be brought about by partial or complete automation of irrigation canals. A local optimal control technique (control of an individual gate) for operation of an irrigation canal with a single reach has been developed. By using the concepts of control theory, an expression for an upstream gate opening of an irrigation canal reach operated based upon a constant-level control is obtained. In the derivation, the canal reach between two gates is divided into N nodes, and the finite difference forms of the continuity and the momentum equations are written for each node. The Taylor series is applied to linearize the equations around the initial steady state or equilibrium conditions. The linearized equations are then arranged to form a set of equations, called state equations in control theory jargon. The linear quadratic regulator theory is applied to derive an expression for the optimal gate opening to bring the system back to the equilibrium condition in the presence of known constant disturbances and found to be acceptable as long as the disturbances are less than 20% of the original flow rate in the canal reach. The results obtained from the optimal theory are currently being evaluated using an unsteady open-channel flow model. (Author's abstract)
W91-03421

DEVICE FOR REDUCING THE EFFECTS OF WAVE ACTION IN SHALLOW WATER.
Mount Allison Univ., Sackville (New Brunswick). Dept. of Biology.
For primary bibliographic entry see Field 2L.
W91-03487

DEVELOPMENT OF A NATIONAL HYDROPOWER INDUSTRY IN NEPAL.
BPC Hydroconsult, Kathmandu (Nepal).
For primary bibliographic entry see Field 8C.
W91-03512

SMALL AND MICRO HYDRO IN THE USSR.
Hydroproject, Moscow (USSR).
For primary bibliographic entry see Field 8C.
W91-03513

SMALL HYDRO DEVELOPMENT IN CHINA: ACHIEVEMENTS AND PROSPECTS.
Water Conservancy Hydroelectric Power Scientific Research Inst., Beijing (China).
For primary bibliographic entry see Field 8C.
W91-03514

SMALL HYDRO DEVELOPMENT IN ETHIOPIA.
Fichtner Development Engineering G.m.b.H., Stuttgart (Germany, F.R.).
For primary bibliographic entry see Field 8C.
W91-03515

REGULATION STORAGE FOR MINI HYDRO SCHEMES.
Tonkin and Taylor Ltd., Auckland (New Zealand).
For primary bibliographic entry see Field 8C.
W91-03516

DEVELOPMENT AND APPRAISAL OF MINI HYDRO IN REMOTE AREAS.
Duke Power Co., Charlotte, NC.
For primary bibliographic entry see Field 8C.
W91-03517

MATUTINAO SCHEME PRESERVES THE ENVIRONMENT.
Asia-Pacific Regional Network for Small Hydropower, Badian (Philippines).
For primary bibliographic entry see Field 8C.
W91-03518

ACCELERATING SHP DEVELOPMENT.
For primary bibliographic entry see Field 8C.
W91-03519

DEVELOPMENT AND EVALUATION OF A RUBBER 'DUCK BILL' TIDE GATE.
Freeman (Peter A.) and Associates, Inc., Berlin, MD.
P. A. Freeman, A. B. Forndran, and R. Field.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-188379. Price codes: E03 in paper copy, E03 in microfiche. Report No. EPA/600/2-89/020, May 1989. 88p, 37 fig, 7 tab, 4 ref. EPA Contract No. CR-807822.

Descriptors: *Hydraulic structures, *Sewer infiltration, *Sewer systems, *Tide gates, *Tidewater, Debris, Economic aspects, Installation, New York.

The inflow of tidal waters into combined sewer interceptor systems places a hydraulic loading on a treatment plant, and the salts contained in tidal water further aggravate treatment efficiency and accelerate sewerage system deterioration. Tide gates are installed in these systems to prevent tidal inflow. A prototype testing of an alternative tide gate design was accomplished in New York to explore improvements to conventional flap gate design. A unique 54 in diameter rubber 'duck bill' tide gate (RTG) was fabricated and installed in a typical NYC tide gate chamber. The operation of the gate was observed over two years. The RTG was very effective in preventing the inflow of tidal waters and generally showed equal or improved performance compared to a typical flap gate. Hydraulically, the RTG was supposed to open to release storm flows at a positive difference in upstream head of six in. and to remain closed preventing inflow at a downstream positive head up to eight ft during high tide. Only minor inflow was observed when debris was introduced into the RTG, however capability of self-cleaning was exhibited. Inflow would be significantly greater if similar size debris was lodged in the conventional flap-type gate. The maintenance crews observed no incident where the manual removal of debris was required. The existing chamber required minor modifications for the installation of the RTG. The method of adapting the RTG to an existing tide gate frame is critical to ensuring the reliability of the installation. The RTG was exposed on occasions to gale force winds and heavy rainfall during the two years of operation in New York City. Results of the project indicate that the RTG can provide low maintenance and reliable performance as a cost effective alternative to conventional tide gates. (Author's abstract)
W91-03603

8B. Hydraulics

VELOCITIES INDUCED BY COMMERCIAL NAVIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
S. T. Maynord.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report HL-90-15. September 1990. 137 p, 5 photo, 14 tab, 2 append.

Descriptors: *Flow velocity, *Hydraulic models, *Hydraulics, *Model studies, *Navigation, Boats, Flow pattern, Hydraulic profiles, Hydrodynamics, Propellers.

Studies were conducted to determine the velocities induced by commercial navigation on large inland waterways. The velocity-inducing mechanisms addressed in this study include propeller jets and the displacement effects of the vessel. Using flow visualization and model and prototype measurements, a better understanding of flow patterns near a moving vessel was obtained. Results illustrated that the propeller jet is not the only mechanism producing significant velocities at the channel bottom. The displacement effects of the vessel also create significant bottom velocities. While return velocities have long been recognized as an effect of the vessel displacement, this study shows that the displacement effects induce a velocity beneath the tow that is generally larger than the return velocity, and is not influenced by channel size except for relatively low blockage ratios. Predictive relations were developed for return velocities, propeller jet velocities, and displacement velocities. (Author's abstract)
W91-03009

SAN ROMAN BYPASS CHANNEL OVERFLOW WEIR CONTRA COSTA COUNTY, CALIFORNIA: HYDRAULIC MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
W. G. Davis.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report No. HL-90-14, September 1990. 64 p, 2 fig, 16 tab, 10 photos, 20 plates.

Descriptors: *Hydraulic models, *Model studies, *Overflow, *San Ramon Bypass Channel, *Weirs, California, Channel flow, Flow discharge, Flow models, Flow profiles, Hydraulic profiles, Mannings equation.

Tests were conducted on a 1:25-scale model of the San Ramon Bypass Channel, Contra Costa County, California, to develop an overflow weir to remove flows from the channel in excess of the 100-year frequency discharge. The overflow weir would remove flows upstream of the covered channel reach to maintain open channel flow conditions through the covered reach, and not to exceed channel capacity downstream of the covered reach. The model presented reproduced approximately 900 feet of the San Ramon Bypass Channel, 100 feet on the Sans Crainte Creek channel, and 400 feet of the catch channel. The model was constructed so that the slopes of the channels could be adjusted to reproduce various energy gradients equivalent to those resulting from different prototype Manning's n roughness factors. The slope of the high velocity channels were adjusted to reproduce the energy gradient resulting from a Manning's n roughness factor of 0.014 in the prototype. These tests were conducted with an overflow weir length of 125 feet and weir height of 13.25 ft. Water surface profiles and discharges over the weir were recorded with various channel discharges. The divider wall at the downstream end of the weir was streamlined by reducing the angle 15 degrees where the flow was being deflected, and placing a 3 inch radius on the nose of the divider to split the flow. This resulted in satisfactory flow conditions at the weir for all discharges tested. (Lantz-PTT)
W91-03011

INTAKE STRUCTURE OPERATION STUDY: ELK CREEK DAM, OREGON.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8A.
W91-03012

LOUISIANA SCOUR ANALYSIS MANAGEMENT SYSTEM (LASAMS).
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
R. Narasimhan, J. F. Cruise, D. P. Argialas, A. Strautmann, and K. Arora.
IN: Water: Laws and Management. American Water Resources Association, Bethesda, Maryland, 1989. p 11A-9--11A-19, 6 fig, 2 ref.

Descriptors: *Computer models, *Data interpretation, *Louisiana, *Louisiana Scour Analysis Management Sys, *Piers, *Scour, Bridges, Highway construction, Monitoring.

The scouring of the piers supporting highway bridges has come to be recognized as a major problem facing the highway engineer. It has become increasingly obvious that bridges that face possible scour situations must be monitored during their lifetimes. Much data will be collected during the monitoring phase. A computerized system for the storage, organization, analysis and display of field collected scour data is presented. The system accepts input from the user, and based on user specifications, allows the data to be organized and viewed in a variety of formats. These include cross sections from scour measurements at selected locations upstream or downstream of the bridge, longitudinal profiles through a selected pier, or the temporal history of maximum scour activity within a specified area near the bridge. The data may be viewed in tabular as well as graphical formats. In addition, the available scour data were analyzed and used to develop regression equations which relate long-term channel degradation to flow and geometric variables. These equations were incorporated into the computer system so that the user may input desired hypothetical discharges and stages so that the system can compute the resulting hypothetical long-term scour. This hypothetical value is then added to the scour activity graphs so that the hypothetical bottom elevation can be compared to the existing bottom and critical pier elevations. (See also W91-03032) (Author's abstract)
W91-03076

HYDRAULICS OF CULVERT FISHWAYS III: WEIR BAFFLE CULVERT FISHWAYS.
Alberta Univ., Edmonton. Dept of Chemical Engineering.
For primary bibliographic entry see Field 8I.
W91-03306

AUGMENTATION OF WATER RESOURCES IN CANAL COMMANDED AREA.
Roorkee Univ. (India). Water Resources Development Training Center.
For primary bibliographic entry see Field 4B.
W91-03357

EVALUATION OF OPTIMAL CONSTANT-VOLUME CONTROL FOR IRRIGATION CANALS.
Wyoming Univ., Laramie. Dept. of Agricultural Engineering.
J. M. Reddy.
Applied Mathematical Modelling AMMODL, Vol. 14, No. 9, p 450-458, September 1990. 11 fig, 14 ref.

Descriptors: *Flow control, *Irrigation canals, *Mathematical models, *Model studies, *Open-channel flow, Canal design, Flow rates, Hydraulic gates, Optimization, Water demand.

A significant benefit of a demand-based or user-oriented water supply system is that such a system should be easier to manage than other systems. A lumped-parameter model was used for simulating the dynamics of an irrigation canal using the concepts of optimal control theory. Using the state-space approach, the problem was formulated as a discrete optimal control problem, and the solutions for gate opening in the presence of known variations in water withdrawal rates were obtained by solving the algebraic Riccati equation. An example problem was considered, and the variations in the depth of flow obtained by using the optimal control theory were compared with the results obtained from an unsteady open-channel flow model. For small and slow changes in the flow rates, the difference between the two models in predicting the changes in water surface elevation was not significant. However, as the variations in withdrawal rates increased, the accuracy of the optimal control model (which is based upon small perturbations around the uniform flow) in predicting the

water surface elevations decreased. (Author's abstract)
W91-03413

WHY SEDIMENTS DEPOSIT IN LINED CHANNELS.
Irrigation and Power Research Inst., Amritsar (India).
For primary bibliographic entry see Field 2J.
W91-03419

HYDRAULICS OF INTERRILL OVERLAND FLOW ON A SEMI-ARID HILLSLOPE, SOUTHERN ARIZONA.
Keele Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W91-03552

ANALYSIS OF PORE PRESSURE BEHAVIOR OF A ROCKFILL DAM DURING RESERVOIR FILLING.
K. Nakagawa, and I. Matsui.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-753443. Price codes: A03 in paper copy, A01 in microfiche. 27p, 19 fig, 6 tab. Abkiko Research Laboratory Rep. No. U87008, (1988). English summary.

Descriptors: *Dam stability, *Doyoh Dam, *Japan, *Pore pressure, *Reservoir operation, *Rockfill dams, Finite element analysis, Stress, Water level.

The numerical analysis of the behaviour of Doyoh Dam which was constructed in 1986 by Chugoku Power Electric Co. Ltd is reported. The procedure uses a finite element analysis of the coupled process between the deformation of the dam and the pore pressure behavior in the core zone. This procedure was applied to the analysis of the behavior of the dam during construction, during reservoir filling, and during the operation to generate the electric power. Comparison of the primary prediction with the observation from the earlier period of construction required the inputed characteristics of the materials in the calculation to be revised. These characteristics turned out good agreement between the calculated results and the measured values of the dam behavior during construction. Therefore, this reexamination of the inputed characteristics is necessary to improve the reliability of the calculation for following dam behavior. It is predicted that reservoir filling influences the distribution of the residual pore pressure after construction but does not raise the maximum value. Calculations show that the change in dam water level during powerplant operation causes pore pressure movement in the core which is not serious enough to affect the stability of the dam. (Author's abstract)
W91-03591

8C. Hydraulic Machinery

NUMERICAL MODELING OF PRESSURE-REDUCING VALVES IN WATER DISTRIBUTION NETWORK SYSTEMS.
Lakehead Univ., Thunder Bay (Ontario). Dept. of Civil Engineering.
U. S. Panu.
Canadian Journal of Civil Engineering CJCEB8, Vol. 17, No. 4, p 547-557, August 1990. 4 fig, 2 tab, 12 ref, append.

Descriptors: *Computer models, *Model studies, *Networks, *Pressure conduits, *Valves, *Water distribution, Flow rates, Friction loss, Hydraulics, Mathematical models, Numerical analysis.

There are difficulties in representing pressure-reducing valves (PRVs) in network-analysis models when using the Hazen-Williams friction factor because the specific dimensions of the PRVs are not taken into consideration. To evaluate the performance of the WATER model in representing PRVs, a test network was created in the form of a computer model. Various tests were conducted on each of three PRVs with different dimensions under both low and high differential head conditions. Results showed that within a certain range of head loss in all three PRVs, the WATER model allowed an excessive flow rate compared with the maximum allowable flow rate for each one of the actual PRVs. The use of modified frictions factors provided an adequate basis for representing pipes containing PRVs in network-analysis models. A significant reduction in computational effort was achieved with modified friction factors and the proposed modifications did not require any alteration to the model structure. The values of modified friction factors for any specified network representation containing an appurtenance are provided to the model through the input data files. When modified friction factors were applied to the Greater Victoria (British Columbia) Water District (GVWD) network, they reduced by half the number of trial runs required to calibrate the GVWD network system to specific flow rates and pressures. The use of modified friction factors also eliminated the need for continuous adjustments of the downstream set points of the PRVs when they had reached their full-wide-open condition. (Geiger-PTT)
W91-03305

RIVER INTAKE WORKS FOR A HYDROELECTRIC PLANT IN PAPUA NEW GUINEA.
Klohn Leonoff Ltd., Richmond (British Columbia).
For primary bibliographic entry see Field 8A.
W91-03307

DEVELOPMENT OF A NATIONAL HYDROPOWER INDUSTRY IN NEPAL.
BPC Hydroconsult, Kathmandu (Nepal).
G. A. Weller.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 10, p 16-18, October 1990. 3 fig, 1 tab, 1 ref.

Descriptors: *Developing countries, *Governmental interrelations, *Hydroelectric plants, *Nepal, *Water resources development, Hydroelectric power, International agreements.

Various organizations have been working with the Nepalese Government for 25 years towards the development of a national hydropower industry. Schemes with capacities of 1 MW and 5.1 MW have been implemented successfully, and work on a 12 MW scheme has begun. The beginning of His Majesty's Government of Nepal partnerships was the formation of a private power company in 1966 to design, construct and operate a 1 MW hydropower plant on the Tinau river in western Nepal. Private companies were chosen because they are able to operate outside the constraint of the strict routines of government, and so can experiment in construction and management. To institutionalize the skills acquired during the construction of the Tinau project, and to maintain the development impetus, a construction company was formed in 1986 based on the Tinau team which is now the leading Nepali contractor in the fields of hydropower and tunnelling. Another project was the 5 MW Andhi Khola hydropower project in western Nepal begun in 1982. The project was financed by Norwegian Government aid, which shares the government's aim to see a national hydropower industry develop. National capability to maintain and repair equipment for hydroplants is essential. Therefore, in 1986, an electro-mechanical company was formed to develop this capability. This group specializes in the design, manufacture and refurbishment of equipment for hydropower developments. All of these companies are working closely with the Nepalese government, the Norwegian government and private international companies, who realize the importance of the development of national hydropower expertise. The experience at Andhi Khola has encouraged the Norwegian Government to fund a 12 MW project on the Jhimruk river in west Nepal which is due for completion in 1993. (Mertz-PTT)
W91-03512

SMALL AND MICRO HYDRO IN THE USSR.
Hydroproject, Moscow (USSR).
L. Mikhailov, B. Fieldman, and V. Linjuchev.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 10, p 21-24, October 1990. 2 fig.

Descriptors: *Hydroelectric power, *USSR, *Water resources development, Hydroelectric plants, Rural development, Turbines.

Small scale hydropower development in the USSR is experiencing its third revival. The first small hydro stations were constructed during the last century. These stations provided isolated supply to industrial sites, towns and rural communities, but construction was not widespread, especially as small thermal powerplants became popular. The second phase of intensive small hydropower development came immediately before and just after the second World War. After this, the construction of small hydro stations dropped off sharply again because of advances in thermal, nuclear and large hydropower. In recent years, attention has again been focused on the well known power potential of small and medium rivers. At this stage in the USSR, the first priority is to establish, at a new engineering level, the manufacture of the well proven Kaplan and Francis turbines. It is important that the prospects for small scale development not be set against the large scale hydropower; the development of small hydro could not replace large scale schemes, but it would help to form a well balanced fuel and energy system for all regions in the USSR. Small hydro should be viewed as a fuel-saving resource, contributing to power supply reliability. (Mertz-PTT)
W91-03513

SMALL HYDRO DEVELOPMENT IN CHINA: ACHIEVEMENTS AND PROSPECTS.
Water Conservancy Hydroelectric Power Scientific Research Inst., Beijing (China).
S. Xiong.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 10, p 27-31, October 1990. 3 tab.

Descriptors: *China, *Developing countries, *Hydroelectric plants, *Hydroelectric power, *Water resources development, Rural development, Water resources.

In 1989, power generation by small hydro in China reached 36 TWh, corresponding to around one-third of the country's total agricultural consumption of electric power in rural areas. With a total installed capacity of 12,620 MW, small hydro accounted for 37.1% of the nation's total hydropower capacity. This represents a 48.5% increase since 1983. In terms of the number of small hydro stations in operation, their total installed capacity and their annual power generation, China ranks first in the world. Although the load factor is still low (around 2800 hours per year on average) and the surplus of seasonal energy is large, small hydro plays an important role in supplying electricity to the vast remote and mountainous rural areas. In 1989, on the basis of tentative development plans collected from all the provinces, the Department of Rural Hydropower prepared a small hydropower development program for the decade. This program sets two main targets. One target is to bring the nation's total small hydropower capacity up to 23.2 GW by the end of the year 2000, with an increase of 10,580 MW of installed capacity within the 11 years to come. In connection with newly added capacity, 400,000 km of transmission lines and a 46,400 MVA capacity of transformers will be completed and added to small rural power grids. The second target is to carry out the second national rural electrification campaign. With the experience obtained from the first campaign between 1984-1990, at another 500 counties, primary rural electrification is planned to be installed before the turn of the century. (Mertz-PTT)
W91-03514

SMALL HYDRO DEVELOPMENT IN ETHIOPIA.
Fichtner Development Engineering G.m.b.H., Stuttgart (Germany, F.R.).

H. Fitjer.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 10, p 33-38, October 1990. 5 fig, 1 tab, 4 ref.

Descriptors: *Developing countries, *Ethiopia, *Hydroelectric power, *Water resources development, Hydroelectric plants, Rural development.

Ethiopia, which has abundant hydropower resources in certain parts of the country, has embarked on a small hydropower development program to speed up electricity supply from renewable resources in remote areas. Small hydro development in Ethiopia has reached a point where planning can be covered largely with the country's own manpower, thanks to UN support during the past decade. Funding of project implementation continues to mark the critical path of the projects. Ethiopian Electric Light & Power Authority has developed its own construction capacity, so that it will be able to take over the execution of the civil works of future small hydropower projects. Foreign support is urgently needed to maintain the momentum of the development reached so far. Recently, interest in micro hydro development has also increased in Ethiopia, and the first concrete steps have been taken for the preparation of a rational approach to a micro hydro development program. Progress in this field is greatly dependent on foreign support. (Mertz-PTT)
W91-03515

REGULATION STORAGE FOR MINI HYDRO SCHEMES.
Tonkin and Taylor Ltd., Auckland (New Zealand).
M. D. Palmer, and J. N. Duder.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 10, p 40-43, October 1990. 4 fig, 2 tab.

Descriptors: *Design criteria, *Hydroelectric plants, *Hydroelectric power, *Water resources management, Hydraulic design.

At existing mini hydro stations where the rated capacity is not more than the peak load, it may be possible to achieve some enhancement of total energy yield and/or rated capacity by introducing storage for daily flow regulation. Similarly, it is possible in some circumstances to reduce the capital cost of the headrace in addition to obtaining enhanced output. The benefits of the provision of storage include making better use of extreme dry season flows, reducing the capacity/size of the low pressure condiut, increasing the period of the year when the plant can operate at peak capacity, using the capacity of the plant at lower plant factor, and increasing the energy available to the system. The maximum benefit is available for isolated schemes, for which the peak load is approximately equal to the yield from the catchment. The benefit decreases as system load increases, to the point where there is no apparent benefit in the case of a station where the capacity is less than the minimum daily system load, unless the station is run as a peak load station. Design procedures consist of optimizing the volume for the available topographical configuration, catchment yield and scheme capacity, together with selection of station capacity in relation to the flow duration curve and plant capacity factor to obtain the best benefit/cost ratio. Operation and maintenance will include training the operators to use the whole of the pond contents during the peak demand periods, to allow it to fill up between peaks and to take measures for sediment control. (Mertz-PTT)
W91-03516

DEVELOPMENT AND APPRAISAL OF MINI HYDRO IN REMOTE AREAS.
Duke Power Co., Charlotte, NC.
H. G. McKay, B. V. Rydbeck, W. D. Wright, and H. Erdmannsdorfer.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 10, p 45-51, October 1990. 4 fig, 2 tab.

Descriptors: *Hydroelectric plants, *Kenya, *Water resources development, Capital costs, Cost analysis, Cost-benefit analysis, Economic aspects, Foreign design practices, Hydroelectric power.

Methodology for the implementation of small scale hydro plants in remote areas of developing countries has been developed by a German turbine manufacturer; it has been used for the development of the Tenwek 320 kw powerplant in Kenya. The 320 kilowatt hydro plant installed at the Tenwek hospital has operated reliably since its commissioning in 1987. The construction project was a demanding effort for the volunteer engineers and missionaries. However, excellent communication and cooperation with the consulting engineer and the equipment supplier, coupled with the local labor force and its supervision, allowed the project to be completed successfully for a price of $830,000. This is $2600/kw installed for one unit. The powerhouse and intake have been designed to add another 320 kw unit at a later date. If the second unit is added, the cost for the total project is estimated to be approximately $1800/kw installed. The real justification for the project is born out by the fact that the hospital has reduced its operating costs by approximately $150,000, even in the first years of operation. This reduction in cost is directly attributable to fuel cost savings. The hydroelectric plant will thus pay for itself in approximately six to seven years. (Mertz-PTT)
W91-03517

MATUTINAO SCHEME PRESERVES THE ENVIRONMENT.
Asia-Pacific Regional Network for Small Hydropower, Badian (Philippines).
Z. A. Santos.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 10, p 61-62, October 1990.

Descriptors: *Hydroelectric plants, *Hydroelectric power, *Philippines, *Water resources development, Rural development, Social aspects, Social impact.

As an integral part of the Philippine Government's rural development program, a rural energy program was established in the early 1980s to produce cheap and reliable power to promote the productivity of small industries and agriculture. Fifteen mini hydropower stations have been completed so far. The first hydropower station in the Philippine-German Special Energy Program, Matutinao, is now under construction. It is a 720 kilowatt project at the village of Matutinao, in Badian, on the island of Cebu, about 110 km from Cebu city. About 2000 people live in the project area. The need to preserve nature as a whole in the valley of the Matutinao river was recognized. Construction work was reduced to a minimum, and the use of heavy equipment was banned. No access roads to the weir were constructed, and emphasis was placed on labor-intensive construction methods. A tunnel was designed instead of a headrace, and the weir and powerhouse were located at sites where they would not disturb the falls or the view of the area. Local people were hired as laborers. This increased their income and reduce the number of people migrating to other areas to work. The Matutinao mini hydro scheme in the Philippines is likely to serve as a model for future rural electrification schemes in the Philippines. It is an example of a project where the local community played an active role, and where the objective was not simply to produce electricity, but to improve the livelihood of the local people and to preserve the natural beauty of the surrounding area. (Mertz-PTT)
W91-03518

ACCELERATING SHP DEVELOPMENT.
M. Botejue.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 10, p 62-66, October 1990.

Descriptors: *Developing countries, *Hydroelectric power, *Public policy, *Water policy, *Water resources development, Rural development.

Regulatory constraints are preventing the optimal utilization of small hydropower (SHP) in developing countries. Liberalized policies that promote the development of independent small hydropower will help to increase interest and investment in such schemes. Small scale hydropower generation has largely been displaced by centralized electricity supply. Where opportunities for small hydro generation exist, there are a number of non-technical barriers that inhibit development. In developing countries where power generation is dependent on imported fuels, the optimal development of small hydro power should receive priority. Prior to implementing such policies long term development strategies for the region should be specified. Financial incentives should be created for harnessing small hydro generation and environmental and regulatory constraints should be addressed. Pay rates for power transfer and technical specifications and standards for connecting to the regional power grid must be established. With the regional grid opened as a carrier and a distributor of power, opportunities will be created for independent power generation. Plantation sector industries, irrigation districts, rural cooperatives and private investors will all be involved. The growth of such projects will open challenging opportunities for dynamic young engineers and managers. (Mertz-PTT)
W91-03519

8E. Rock Mechanics and Geology

SOLID-EARTH SCIENCE DATA BASES.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 7C.
W91-03001

GEOLOGY FOR ENVIRONMENTAL PLANNING IN MONROE COUNTY, INDIANA.
Indiana Geological Survey, Bloomington.
For primary bibliographic entry see Field 6G.
W91-03646

HYDROLOGY OF LIMESTONE TERRANES: ANNOTATED BIBLIOGRAPHY OF CARBONATE ROCKS, VOLUME THREE.
International Association of Hydrologists.
For primary bibliographic entry see Field 2F.
W91-03656

PALYNOSTRATIGRAPHY OF THE CENTRAL WEST MURRAY BASIN.
For primary bibliographic entry see Field 2E.
W91-03904

STRATIGRAPHY AND SEDIMENTOLOGY OF MID-TERTIARY PERMEABILITY BARRIERS IN THE SUBSURFACE OF THE MURRAY BASIN, SOUTHEASTERN AUSTRALIA.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
For primary bibliographic entry see Field 2F.
W91-03908

8G. Materials

SAN ROMAN BYPASS CHANNEL OVERFLOW WEIR CONTRA COSTA COUNTY, CALIFORNIA: HYDRAULIC MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W91-03011

DAM SAFETY: AN EVALUATION OF SOME PROCEDURES FOR DESIGN FLOOD ESTIMATION.
Salford Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W91-03845

8I. Fisheries Engineering

FISHERY FUNCTIONS AND VALUES OF FORESTED RIPARIAN WETLANDS.
Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures.
For primary bibliographic entry see Field 2H.
W91-03084

HYDRAULICS OF CULVERT FISHWAYS III: WEIR BAFFLE CULVERT FISHWAYS.
Alberta Univ., Edmonton. Dept of Chemical Engineering.
N. Rajaratnam, and C. Katopodis.
Canadian Journal of Civil Engineering CJCEB8, Vol. 17, No. 4, p 558-568, August 1990. 15 fig, 1 tab, 9 ref.

Descriptors: *Baffles, *Culverts, *Fish passages, *Hydraulics, *Weirs, Flow velocity, Mathematical studies.

The hydraulics of culvert fishways with weir-type baffles were studied in the laboratory. Weir baffles without slots would be less expensive to build than slotted-weir baffles and would resemble a pool-weir fishway. Baffles with heights equal to 0.15 and 0.1 times the diameter (D) of the culvert were studied with longitudinal spacings of 0.5D and 1.2D. Equations were developed to describe the relation between the discharge, slope, diameter, and the depth of flow. Using these equations it was possible to predict the barrier velocity that would exist at the baffles. The performance of the weir baffles was found to be as good as that of the slotted-weir baffles or slightly better by producing larger depths for smaller flow rates. A spacing of 0.6D was very effective, whereas a spacing of 1.2D appeared to be somewhat too large. During low flows, sediment may settle in the pools, but this might be eroded and transported by larger flows. A certain amount of maintenance of the culvert may be needed. (See also W90-03168) (Geiger-PTT)
W91-03306

EVALUATION OF THE FISHERIES OF THE MACKINAW RIVER BASIN IN CENTRAL ILLINOIS.
Illinois Dept. of Conservation, Aledo.
For primary bibliographic entry see Field 2H.
W91-03504

HABITAT RESTORATION FOR FISH AND WILDLIFE IN BACKWATER LAKES OF THE ILLINOIS RIVER.
Illinois State Water Survey, Peoria. Water Quality Section.
For primary bibliographic entry see Field 5G.
W91-03616

DEVELOPMENT OF THE LAKE ONTARIO SPORTFISHERY: SOCIOECONOMIC IMPACTS IN NEW YORK STATE.
New York Sea Grant Extension Program, Oswego.
For primary bibliographic entry see Field 2H.
W91-03700

BIOMANIPULATION: THE NEXT PHASE--MAKING IT STABLE.
Minnesota Univ., Minneapolis. Limnological Research Center.
For primary bibliographic entry see Field 5G.
W91-03762

FISH IN SHALLOW AREAS IN MORETON BAY, QUEENSLAND AND FACTORS AFFECTING THEIR DISTRIBUTION.
Queensland Dept. of Primary Industries, Brisbane (Australia). Fisheries Management Branch.
For primary bibliographic entry see Field 2L.
W91-03814

DEVELOPMENT OF AN INTERDISCIPLINARY PLANNING MODEL FOR WATER AND FISHERY MANAGEMENT.
New Mexico State Univ., Las Cruces. Dept. of Fishery and Wildlife Sciences.
For primary bibliographic entry see Field 6A.
W91-03855

CONSERVATION OF ENDEMIC RAIN FOREST FISHES OF SRI LANKA: RESULTS OF A TRANSLOCATION EXPERIMENT.
California Univ., Davis. Dept. of Wildlife and Fisheries Biology.
E. D. Wikramanayake.
Conservation Biology, Vol. 4, No. 1, p 32-37, March 1990. 1 fig, 3 tab, 23 ref.

Descriptors: *Conservation, *Environmental policy, *Fish conservation, *Fish populations, *Rain forests, *Sri Lanka, *Translocation, Ecosystems, Environmental protection, Forest watersheds, Species diversity, Stream fisheries.

Four potentially endangered species of rain forest fishes, Brabus cumingi, Barbus titteya, and Rasbora vaterifloris, endemic to streams of southwestern Sri Lanka, were translocated in 1981 into a depauperate stream system in the central hills. By 1985, all four species had established self-perpetuating populations in these streams, and had extended their range into adjacent streams. Barbus nigrofasciatus, was one of the most abundant species in these streams. It was widely distributed throughout the stream system and in the slower sections of the Mahaveli Ganga (Mahaveli River), and occupied a wide range of macrohabitat and microhabitat types. The other three species were more specialized in their habitat and diet, and thus were patchily distributed. The microhabitats occupied by B. cumingi, B. titteya, and R. vaterifloris resembled the specialized microhabitats they occupy in their native streams. Presumably because of their specializations, these three species were not as abundant as B. nigrofasciatus. Overall, the biology and distribution of the four species will enable them to survive spatially small-scale environmental perturbations. The results suggest that translocations are a feasible way of conserving other endemic fishes of Sri Lanka threatened with extinction. However, such translocations must be carefully planned, with consideration for the indigenous community as well as the ecological requirements and genetic integrity of the target species. (Author's abstract)
W91-03869

9. MANPOWER, GRANTS AND FACILITIES

9D. Grants, Contracts, and Research Act Allotments

FISCAL YEAR 1988 PROGRAM REPORT (WYOMING WATER RESEARCH CENTER).
Wyoming Univ., Laramie. Water Resources Research Inst.
S. P. Gloss.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-217225/AS. Price codes: A04 in paper copy, A01 in microfiche. Program Report G1600-01, July 1989. 56p. USGS Contract No. 14-08-0001-G1600. USGS Project No. G1600-01.

Descriptors: *Information transfer, *Research, *Training, *Water resources Institutes, *Wyoming, Education, Projects.

Four research projects were funded under the FY88 program, as well as an information transfer program. Two projects funded through the WWRC state program were submitted as matching. A short statement identifying each project follows: (1) The mechanics of groundwater recharge and the influences of geologic structure and stratigraphy on this recharge were studied for western Wyoming foreland and thrustbelt environments. Three distinct types of groundwater storage were found to occur in these environments; (2) Uncertainty analysis and risk evaluation was performed on parameters of a dissolved oxygen (DO) water quality model. It was found that uncertainty in DO prediction depends on the classification of the stream and the use of a correct probability distribution for DO concentration; (3) Microorganisms which inhabit the rhizosphere are being studied to see if they play a major role in the modification of the bioavailibility of selenium. Results to date suggest that vesicular arbuscular fungi found on the roots of plants in seleniferous soils are important mediators of plant selenium uptake; (4) An evaluation of potential toxicity effects of saline discharges from oil production operations on a portion of a stream system in Wyoming has indicated to date that concentrations of Na(+), K(+), Cl(-), HCO3(-), and CO3(2-) from these saline discharges is significantly contributing to observed toxicity; (5) The hydrologic, geomorphic and biologic responses of conveying municipal water through an ephemeral watercourse are being measured and evaluated. A well defined channel has begun to form and aquatic habitat are beginning to establish themselves; and (6) The Wyoming Water Research Center operates and maintains a high mountain watershed observatory which is densely instrumented for the purposes of hydrologic, water quality, and climatologic research and educational instruction. It is presently being used by the U.S. Forest Service for atmospheric deposition studies in cooperation with the University of Wyoming. Information transfer was accomplished through field tours, professional papers, a newsletter, law journal publications, seminars and updating data and bibliographic information sources for the State of Wyoming on regional and state water issues. (USGS)
W91-02983

10. SCIENTIFIC AND TECHNICAL INFORMATION

10C. Secondary Publication And Distribution

WASTE TREATMENT BY REVERSE OSMOSIS AND MEMBRANE PROCESSES: INDUSTRIAL (NOV 76-OCT 89). CITATIONS FROM THE COMPENDEX DATABASE.
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-853532/AS. Price codes: NO1 in paper copy, NO1 in microfiche. December 1989. 130p.

Descriptors: *Bibliographies, *Industrial wastewater, *Literature review, *Membrane processes, *Reverse osmosis, *Wastewater treatment, Chemical wastes, Dyes, Electrodialysis, Fluorides, Ion exchange, Metals, Nitrates, Pulp wastes, Radioactive wastes, Sodium, Steel mill wastes, Textile wastes.

This bibliography contains citations concerning the use of membranes to treat industrial waste water. Reverse osmosis, ion exchange, electrodialysis, and ultrafiltration processes are described. Removal of metals, sodium compounds, nitrates, fluorides, dyes, and radioactive waste using membranes is examined. Wastewater treatment for chemical, pulp, textile, and steel mills using this technology is included. (This updated bibliography contains 294 citations, 13 of which are new entries to the previous edition.)
W91-03568

TOXICITY BIOASSAYS: WATER POLLUTION EFFECTS ON AQUATIC ANIMALS AND PLANTS (JUN 86-FEB 90). CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE.
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-862798/AS. Price codes: NO1 in paper copy, NO1 in microfiche. March 1990. 94p.

Descriptors: *Bibliographies, *Bioassay, *Literature review, *Toxicity, *Water pollution effects, Aquatic animals, Aquatic plants, Growth, Mortality, Reproduction.

This bibliography contains citations concerning toxicity bioassay studies of water pollution effects on reproduction, growth, and mortality of aquatic animals and plants. Industrial and agricultural water pollutants such as metals, chemicals, pesticides, and herbicides are evaluated and tested. Standard fishes and algal assays are used to determine effects of potential toxicants. (This updated bibliography contains 145 citations, 51 of which are new entries to the previous edition.)
W91-03569

WASTEWATER AND WATER TREATMENT: ANION EXCHANGE (JAN 77-MAY 89). CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE.
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-862916/AS. Price codes: NO1 in paper copy, NO1 in microfiche. June 1989. 97p.

Descriptors: *Anion exchange, *Bibliographies, *Literature review, *Wastewater treatment, *Water treatment, Chromatography, Desalination, Drinking water, Membranes, Resins.

This bibliography contains citations concerning the theory, methods, and applications of anion exchange in the treatment of potable water and wastewater. Topics include anion exchange resins and membranes, desalination techniques, and process evaluations. Methods for anion analysis using chromatographic techniques are also considered. (This updated bibliography contains 165 citations, 35 of which are new entries to the previous edition.)
W91-03570

EFFLUENT TREATMENT IN THE PAINT AND COATING INDUSTRY (JAN 80-MAY 89). CITATIONS FROM THE WORLD SURFACE COATINGS ABSTRACTS DATABASE.
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-863583/AS. Price codes: NO1 in paper copy, NO1 in microfiche. June 1989. 43p.

Descriptors: *Bibliographies, *Industrial wastes, *Literature review, *Wastewater treatment, Activated carbon, Biological treatment, Filters, Hydrogen peroxide, Paints, Recovery systems, Solvents.

This bibliography contains citations concerning the analysis and treatment of effluents from the coating industry. Filters used for solvent absorption and recovery, activated carbon absorption of paint fumes, hydrogen peroxide treatment of wastes, effluent heat recovery, and biological treatments are discussed. (This updated bibliography contains 101 citations, 18 of which are new entries to the previous edition.)
W91-03571

EFFLUENT TREATMENT IN THE TEXTILE INDUSTRY: DYES (JAN 83-JUN 89). CITATIONS FROM THE WORLD TEXTILE ABSTRACTS DATABASE.
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-864359/AS. Price codes: NO1 in paper copy, NO1 in microfiche. June 1989. 80p.

Descriptors: *Bibliographies, *Industrial wastes, *Literature review, *Textile mill wastes, *Wastewater treatment, Adsorption, Bacterial treatment, Color removal, Dyes, Electrolysis, Flocculation, Manganese, Membranes, Ozonation, Ultrafiltration.

This bibliography contains citations concerning the treatment and reuse of textile industry effluents that contain dyes. Bacteria that absorb dyes, neutralization of dye effluents, color removal by ozonization and by treatment with manganese solid waste, flocculation treatment, and dye absorption methods and materials are discussed. Membrane treatment, electrolysis, and ultrafiltration methods of removing dyes from wastewater are also considered. Reuse of dye containing effluents are also considered. Textile effluents that do not contain dyes are discussed in another bibliography. (This updated bibliography contains 200 citations, 33 of which are new entries to the previous edition.)
W91-03572

ANIMAL WASTE POLLUTION AND ITS CONTROL (JAN 70-JUN 89). CITATIONS FROM THE NTIS BIBLIOGRAPHIC DATABASE.
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-865430/AS. Price codes: NO1 in paper copy, NO1 in microfiche. July 1989. 162p.

Descriptors: *Animal wastes, *Bibliographies, *Feedlot wastes, *Literature review, *Waste treatment, Anaerobic digestion, Animal processing wastes, Fertilizers, Manure, Runoff.

This bibliography contains citations concerning pollution effects and pollution control of animal wastes and animal processing wastes. Reports are included on feedlot waste pollution and control, pollution from manure used in fertilization, water runoff from farms, dairy and livestock wastes, rendering wastes, poultry processing wastes, ecological aspects, and hoghouse waste control. Also included in the reports are pollution control by anaerobic digestion of manures. (This updated bibliography contains 314 citations, 42 of which are new entries to the previous edition.)
W91-03573

GROUND WATER POLLUTION TRANSPORT: MODEL STUDIES (JAN 75-MAR 89).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-858831/AS. Price codes: N01 in paper copy, N01 in microfiche. April 1989. 103p.

Descriptors: *Bibliographies, *Groundwater pollution, *Model studies, *Path of pollutants, *Simulation analysis, Geohydrology, Groundwater movement, Pollutant transport.

This bibliography contains citations concerning analytical and numerical simulations of the movement and distribution of contaminants in groundwater. Pollutant transport and dispersion, two and three-dimensional modeling in homogeneous and heterogeneous materials, and site studies in specific geohydrologic environments are among the topics discussed. Theoretical analyses and practical applications are included. (Contains 171 citations). (Author's abstract)
W91-03604

HYDROLOGY OF LIMESTONE TERRANES: ANNOTATED BIBLIOGRAPHY OF CARBONATE ROCKS, VOLUME THREE.
International Association of Hydrologists.
For primary bibliographic entry see Field 2F.
W91-03656

10D. Specialized Information Center Services

NATIONAL WATER INFORMATION SYSTEM USER'S MANUAL. VOLUME 2, CHAPTER 4. GROUND-WATER SITE INVENTORY SYSTEM.
For primary bibliographic entry see Field 7C.
W91-03013

GEOCHEMICAL COMPUTER CODES: A REVIEW, FINAL REPORT.
For primary bibliographic entry see Field 7C.
W91-03027

10F. Preparation Of Reviews

SEQUENTIAL PRECIPITATION SAMPLERS: A LITERATURE REVIEW.
Nebraska Univ. at Omaha. Dept. of Chemistry.
For primary bibliographic entry see Field 2B.
W91-03294

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W91-03819 2L
W91-03820 2H
W91-03821 5C
W91-03822 2H
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W91-03826 2H
W91-03827 2H
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W91-03830 2H
W91-03831 2L
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W91-03833 5C
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W91-03836 2L
W91-03837 5C
W91-03838 2L
W91-03839 5A
W91-03840 2E
W91-03841 2B
W91-03842 4C
W91-03843 2F
W91-03844 2E
W91-03845 7B
W91-03846 5A
W91-03847 5B
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W91-03850 2B
W91-03851 7B
W91-03852 5G
W91-03853 2A
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W91-03855 6A
W91-03856 2A
W91-03857 5B
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W91-03860 2F
W91-03861 6E
W91-03862 5B
W91-03863 2E
W91-03864 2H
W91-03865 2C
W91-03866 5B
W91-03867 2H
W91-03868 7B
W91-03869 8I
W91-03870 6G
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W91-03887 5C
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W91-03891 3C
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W91-03901 7C
W91-03902 2F
W91-03903 2A
W91-03904 2E
W91-03905 2F
W91-03906 2F
W91-03907 7B
W91-03908 2F
W91-03909 7B
W91-03910 5B
W91-03911 2F
W91-03912 2F
W91-03913 5B
W91-03914 2F
W91-03915 5B
W91-03916 5G
W91-03917 5G
W91-03918 7B
W91-03919 7C
W91-03920 7C

Subject Fields

1 NATURE OF WATER

2 WATER CYCLE

3 WATER SUPPLY AUGMENTATION AND CONSERVATION

4 WATER QUANTITY MANAGEMENT AND CONTROL

5 WATER QUALITY MANAGEMENT AND PROTECTION

6 WATER RESOURCES PLANNING

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ORGANIZATIONAL INDEX

ACCESSSION NUMBER INDEX

1991 Price Schedules for the United States, Canada, and Mexico

These prices are for customers in the United States, Canada, and Mexico; other customers, write for price list PR-360-4.

Microfiche & Paper Copy Reports

Standard Prices		*Exception Prices*	
A01	$8.00	E01	$10.00
A02	11.00	E02	12.00
A03	15.00	E03	14.00
A04–A05	17.00	E04	16.50
A06–A09	23.00	E05	18.50
A10–A13	31.00	E06	21.50
A14–A17	39.00	E07	24.00
A18–A21	45.00	E08	27.00
A22–A25	53.00	E09	29.50
A99	*	E10	32.50
		E11	35.00
"N" Codes		E12	38.50
		E13	41.00
N01	$60.00	E14	45.00
N02	59.00	E15	48.50
N03	20.00	E16	53.00
		E17	57.50
		E18	62.00
		E19	69.00
		E20	80.00
		E99	*

Computer Products

Diskettes		*Magnetic Tapes*	
D01	$50	T01	$165
D02	80	T02	220
D03	130	T03	340
D04	180	T04	450
D05	230	T05	560
D06	280	T06	670
D07	330	T07	780
D08	380	T08	890
D09	430	T09	1,000
D10	480	T10	1,110
D11	530	T11	1,220
D12	580	T12	1,330
D13	630	T13	1,440
D14	680	T14	1,550
D15	730	T15	1,660
D16	780	T16	1,770
D17	830	T17	1,880
D18	880	T18	1,990
D19	930	T19	2,100
D99	*	T99	*

* Contact NTIS for price

Prices effective January 1, 1991

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